52

DISCOVERY

FEBRUARY 1958 2/6

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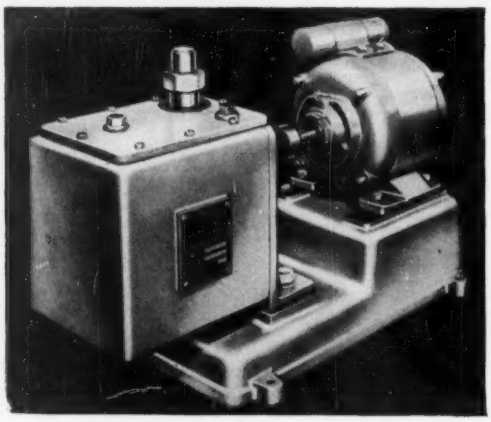

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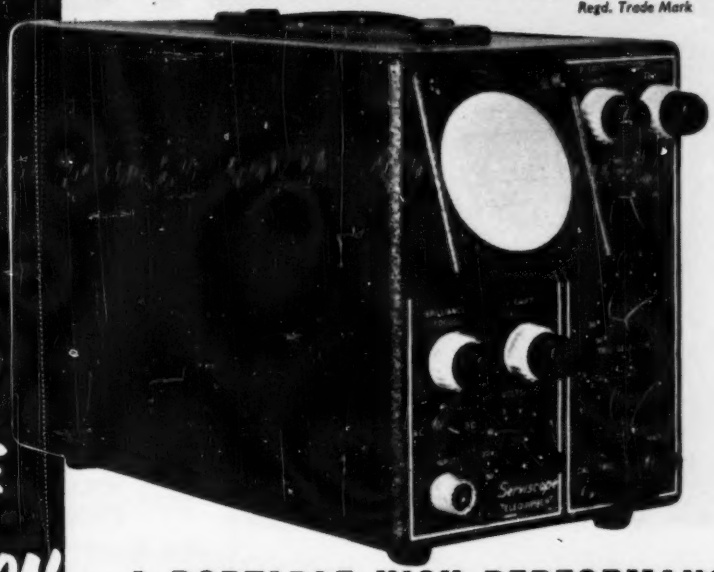

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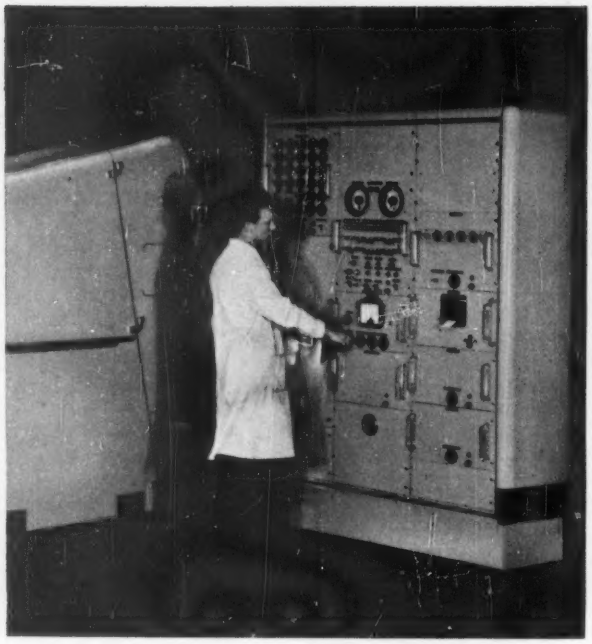

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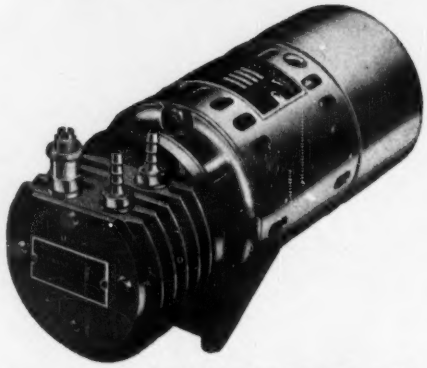

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DISCOVERY

VOLUME XIX FEBRUARY 1958 NUMBER 2

Editor
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Editorial Office
244 High Holborn, W.C.1
CHAncery 6518

Subscription, Distribution and Business Communications to
Jarrold & Sons Ltd, Norwich
Norwich 25261

Advertisement Office
Aldridge Press Ltd,
27 Chancery Lane, W.C.2
HOLborn 8655

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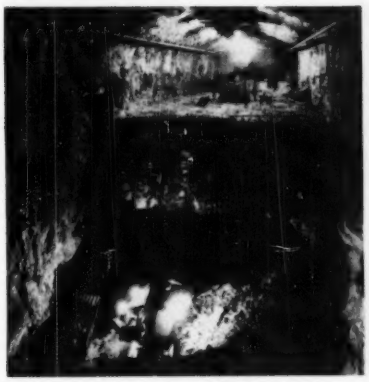

The construction of an underground steam-generating station being built at Stenungsund in southern Sweden. This is one of the two huge turbine generating halls, each of a height as much as 90 ft. and a width of 72 ft. For purposes of defence it is obviously better to place such units underground. Economically, it is cheaper to construct such a station below the surface. (*See* p. 54).

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THE PROGRESS OF SCIENCE

FISSION, FUSION, AND PROFUSION

It now seems likely that, despite the great future once assigned to it, atomic energy from the fission of uranium might only have a relatively short innings after all. This is not fission's fault—it works very well indeed—it's just that fusion, or thermonuclear reactions between light elements, has in fact proved practical and thus opens up a vista which is in many ways much more attractive. It has now been released that both here and in America years of work have been crowned with success and that true thermonuclear reactions have been produced in the laboratory. It would also be reasonable to assume that the Russians, too, have been successful; Kurchatov's famous lecture at Harwell in 1956 (*see* DISCOVERY, 1956, vol. 17, p. 227) showed that at that time they were, if anything, ahead of us.

Fusion is considered important for several very good reasons. Firstly, the fuel. For the fusion reaction the most likely one is deuterium, the heavy isotope of hydrogen. This is present in all natural hydrogen to the extent of one part in about 6000 and so the obvious fuel stockpile is simply water. It has in fact been estimated that there is enough deuterium in the oceans to last the world a million years—even if its consumption of power were 1000 times its present level. Of course the deuterium has to be separated in the form of heavy water and this is an expensive operation. Nevertheless it is well worth it, for estimates have shown that although it takes 800 kWh of electricity to separate one gram of deuterium, fusing it all in a thermonuclear reaction would produce something like 24,000 kWh—a spectacular return.

Another advantage of fusion as compared with fission is that there will be no radioactive products to be disposed of; the fuel is used only once and will be safe to handle at all times. This does not mean that there will be no radioactivity round a thermonuclear reactor. In fact there will be a very strong flux of neutrons, but shielding against this is comparatively simple and now well understood.

Further, thermonuclear reactions will probably be inherently very safe in operation because only a very small quantity of fuel will be reacting at a given time. There is no question of a critical size, as in a fission reactor, and it is likely that any fault in the apparatus will simply shut it down immediately.

Finally, and possibly the most attractive feature, it is thought that electricity can be generated direct from the reaction without the trouble and expense of heating a fluid, transferring the heat to water, raising steam and supplying it to a turbogenerator.

Thus the goal is unbelievably attractive. There is no doubt that immense political prestige will come to Britain, the first to demonstrate convincingly that thermonuclear reactions can indeed be used for providing power, and this is the reason why so much secrecy and urgency has surrounded the whole subject. In this age of sputnik diplomacy neither the West nor the East could afford to ignore this factor, and the problem of timing the great announcement was nearly as difficult as that of actually making the reaction go.

At the 1955 Geneva conference the Russians astonished the world when they announced they had a small atomic power station actually working and then promptly gave all the details. Since then giant strides have been made by the West but it is very likely that the Russians are planning to try and bring off a brilliant double by also announcing a successful thermonuclear device, if not an actual power station at the next conference in September, if not before then. The next few months are therefore likely to be critical for scientific prestige.

Now that thermonuclear fusion has been achieved on a laboratory scale how long is it likely to be before a practical reactor will be seen? At the last Geneva conference there seemed to be a general agreement on a figure of twenty years but lately there has been a considerable shortening of the odds and even official spokesmen are beginning to talk in terms of half this period.

From the British point of view all the indications point this way. When the original White Paper plan of February 1955 was announced it was assumed that the Calder Hall type of gas-cooled reactor would be superseded in the early 1960's by more highly rated liquid-cooled types. There is still no sign whatsoever of these materialising and we are going ahead with the revised plan to install about 5000 or 6000 MW of generating capacity by 1965 or 1966 using reactors of the gas-cooled type. This is because it has proved to be very much better than was ever hoped for when Calder Hall was designed, and it is now seen still to have plenty of scope for development. But, and this is the point, it is also likely that the authorities are now so convinced that thermonuclear power can be made to work within a clearly foreseeable time that they have no intention of doing anything very serious about other kinds of fission reactor, except possibly for naval propulsion. Another factor reinforces this view. It is well known that the gas-cooled reactor, while eminently suitable for meeting the electricity system base load, is not likely to be economic when used intermittently for supplying peak demand; for this, something with a much lower capital cost will be needed. Answers to this one will be wanted very soon, for by 1965–6 the big gas-cooled stations planned will be within sight of carrying all the base load on their own.

Whether a thermonuclear reactor would be suitable for base load or peaks is of course not known at present, since it is quite impossible to get any idea of the capital cost. However, from a purely operational point of view it seems very likely that it would do very well for intermittent operation owing to the nature of the process—a flow of gas, deuterium for example, into one end of the reactor with helium coming out of the other.

Although the thermonuclear principle has been proved, a great deal of engineering work must lie ahead before we can know whether power will be produced from it economically, and this must include the obtaining of the fuel. Between the discovery of fission and the first atomic power stations lie about fifteen years; but about five of those were taken up with producing the bomb and setting up nuclear research organisations. This last has been done in most countries and it is likely that fusion research will go much faster. It is probably also within the reach of many more countries because the raw material is readily available to all mankind.

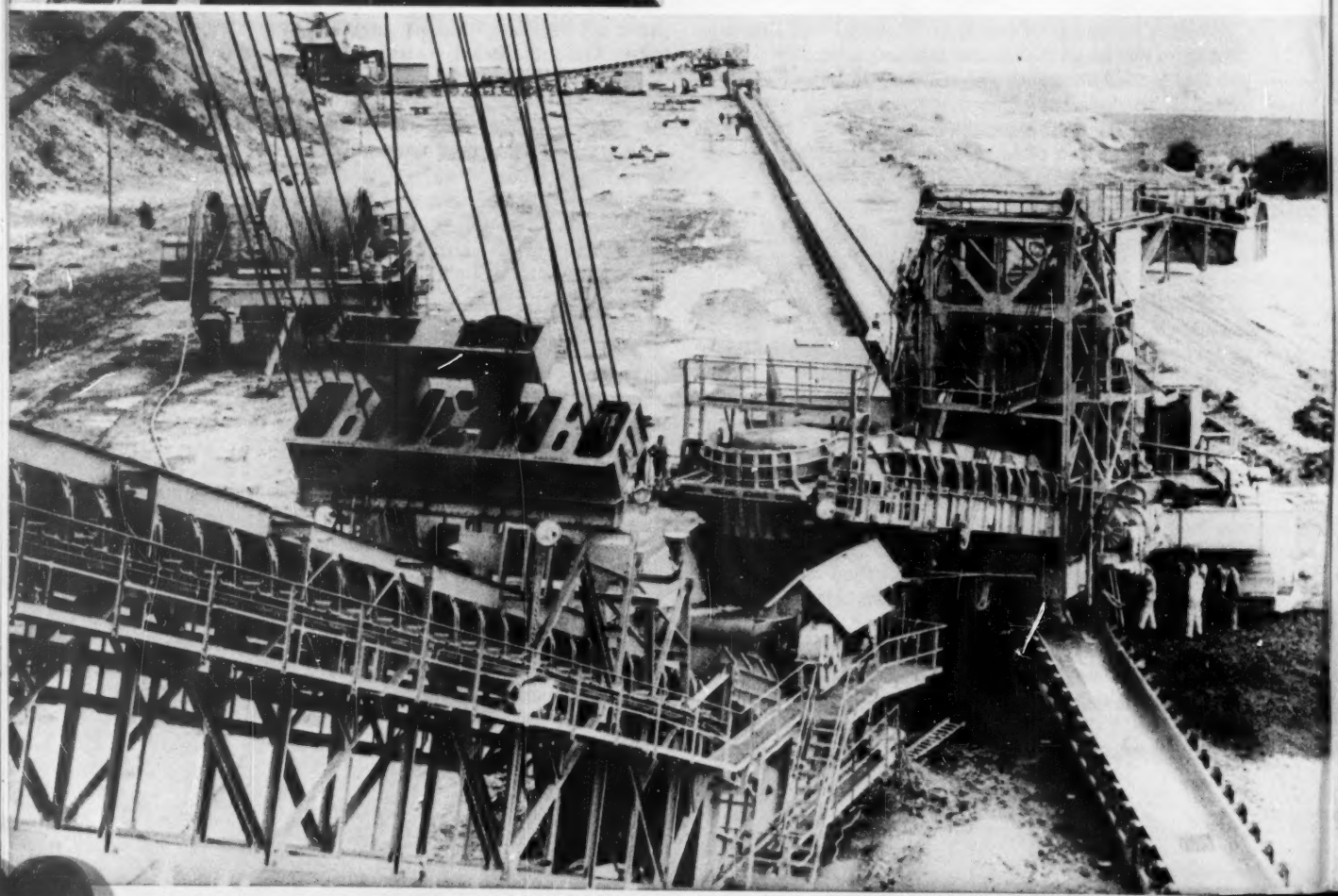
FIG. 1. The huge turntable of the remover which turns through 180 degrees.

BIGGEST EARTH REMOVER

What has been described as the biggest earth-remover in the world has been constructed by the Krupp company for the West German Mining Industry. It operates in conjunction with a giant excavator at Fortuna for the Rheinische AG and puts back a covering of earth after the brown coal has been taken from beneath. It consists of a series of dredges which pick up the soil deposited by hundreds of trucks from Garsdorf-Auenheim-Wiedenfeld, on a conveyor-belt 3300 ft. long and 7 ft. wide. A second belt takes over and carries the soil over a sling-belt excavator to the actual remover, which, with the help of the sling-belt excavator, is able to drive 3000 ft. along its own track. Only after 35 million cu. ft. of earth has been moved is it necessary to move the entire installation. It took the Krupp engineers more than a year to design and construct this gigantic machine. The complete length of the outrigger's arms is 330 ft. The machine is driven by 150 motors, but only six men are needed to operate it; they keep contact with each other by radio. The outrigger arm turns through 180 degrees. Eight caterpillar wheels give support over an area of 6600 sq. ft., and each is 8 ft. by 33 ft.

FIG. 2. A view along the outrigger arm looking towards the remover.

FIG. 3. The second conveyer-belt which takes the earth over a sling-belt excavator to the remover.



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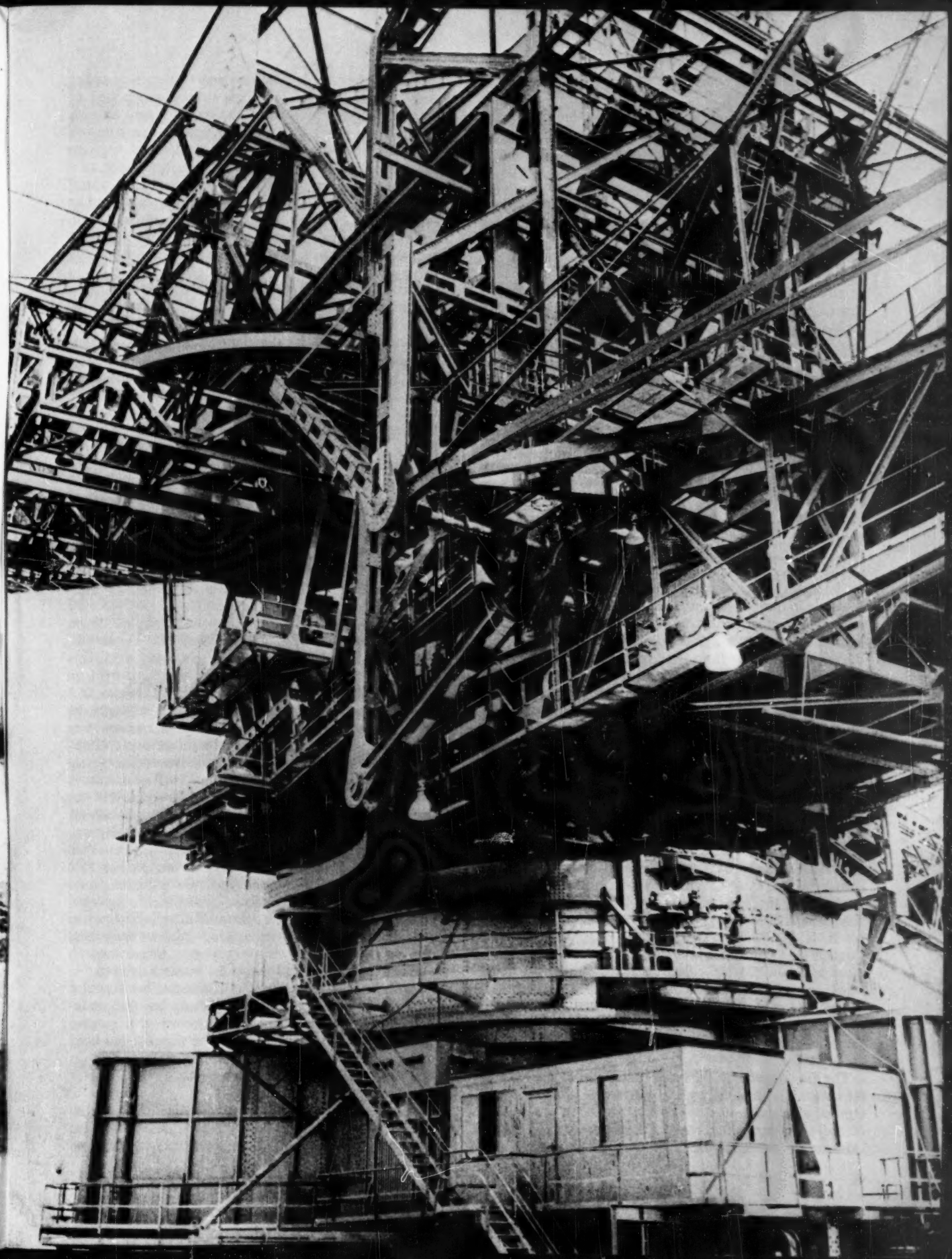


"BACK-ROOM" CONFERS WITH "FRONT-ROOM"

What should be the role of the scientist within the usually cumbersome machinery of government? The reply may go to either of two extremes. A position frequently taken is that the scientist should belong to the top policy council of government. In this relationship he advises on the contribution of science to immediate and long-range national objectives. He can thus influence the status, recognition, and proper utilisation of scientists.

The other extreme opinion describes the scientist as the spoon-fed dependant of a self-sufficient corps of efficient administrators. In this setting he is conceived as the "back-room" boy who can be trusted to come up with world-shaking ideas or clear-cut solutions to complex problems that his seniors in administration in the front offices can hence offer forth. This concept of the controlled feeding of scientists compounds the stereotype of scientists as an impractical lot disinterested in prosaic administration.

It is clear that the scientist in the higher levels of government must develop a keener appreciation of not only overall management policies, and principles of administration, but must learn to handle more effectively the management responsibilities which he will assume as his position becomes more accepted. It is gratifying to note that the British Civil Service is in the vanguard of not only the countries of Western Europe, but also the United States in doing something concrete towards meeting this need.

The Treasury has for the past few years run residential conferences at a country house or a Cambridge college, lasting eight days and attended by about twenty senior scientists, engineers, architects, and administrators of assistant secretary and equivalent rank. The groups are drawn intentionally from different specialities to get the maximum of cross-fertilisation of ideas. The scientists and engineers at this level have usually ceased to become primarily research workers. They now have a responsibility for administration and direction of staff.

The most recent conference on "Management and Organisation for Senior Scientists and Members of the Works Group and Related Classes" was held at Elvetham Hall in Hampshire, November 7–15, 1957, under the chairmanship of Mr P. S. Milner-Barry, who is Director of Organisation and Methods at the Treasury. Among the guest speakers were: Sir Gordon Radley, Director-General of the Post Office, on "Management in the British Service"; Sir Owen H. Wansborough-Jones, Chief Scientist of the Ministry of Supply, on "The Place of Science and Technology in Machinery of Government"; Mr R. H. Quirk of the Office of the Lord President of the Council on "Demand and Supply of Scientific and Technical Manpower"; Mr Louis Petch of the Treasury on "Government as Employer"; and Mr D. J. Clarkson, Personnel Director, Glacier Metal Company Limited, on "Personnel Management in Industry". An additional feature was an all-day visit to the Thornycroft Works at Basingstoke.

The Government as the largest employer of scientists in the country is to be commended for taking the lead in this type of management training. Irrespective of the content of the programme the bringing together of a group of Government scientists and engineers for uninhibited discussions on their work problems and Government policy conveys in itself some justifiable official recognition of their valuable contributions. This, too, is a step towards reducing the natural frustration of imaginative scientists against the seemingly impenetrable hardpan of Government regulations and by-laws. The Treasury which as a Government department tends to be regarded by the typical scientists as a rigidly impersonal control agency, and as responsible for the curbs and barriers that affront him in carrying out his work programme takes on, if not a warmer glow, at least a better perspective as a result of the conference.

The communication between the Treasury and a sampling of the scientist and related professional fields affected by its policies is especially facilitated through the residential type conference. The mutual stimulation between the participants and senior representatives of the Treasury who are present both as the conference staff and as speakers helps to create a more personal and clearer understanding of the Treasury's responsibilities.

Besides their participation in discussions with guest speakers, members of the conference were divided into three syndicates which met regularly each day during the conference programme. These discussions permitted members in a smaller group formation to exchange their views and to pool their experience in more detail. At the conclusion of the conference, the spokesman for each syndicate presented the proposals of his group for improvement both of career prospects and efficiency in the Civil Service. Common to all these groups was the recommendation to the Treasury to increase the flexibility of personnel and fiscal administration as well as to provide career ladders for scientists and engineers to the very top of the Civil Service structure.

SCIENTIFIC RESEARCH IN SCHOOLS

Recently suggestions have been made that it might be helpful to give some scientific advice to science masters and mistresses wishing to pursue research at their schools, and that the recruitment of such teachers might be encouraged if facilities for research in any particular schools are known to exist. To this end a Joint Committee of the Royal Society and the Science Masters' Association has been formed under the chairmanship of Sir Lindor Brown, the Biological Secretary of the Royal Society. The other Royal Society members are Dr F. P. Bowden, F.R.S., Sir Edward Salisbury, F.R.S., and Dr C. G. Williams, while Mr W. Ashhurst, Mr. R. H. Dyball, and Mr. M. C. Nokes are the representatives of the Science Masters' Association. The Committee is to consider the problems confronting science masters and mistresses who wish to pursue research and to arrange for advice for specific research projects.

In order to initiate action, the Committee has issued a note to teachers of science in schools and has also circularised the headmasters and headmistresses of a number of schools in the United Kingdom. The response has been most encouraging and eleven schools had submitted details of research projects and asked advice within a very short time after announcement.

The Committee hopes to be assisted in its work by Fellows of the Royal Society and others at universities who may be willing to discuss projects with those who wish to

carry out research. This kind of contact between university departments which are intimately concerned with research work and schoolmasters and mistresses who so often feel isolated from the academic world would, in the Committee's opinion, be valuable.

It is, of course, appreciated that in many schools there are no adequate facilities, nor has the science staff the opportunity or time to carry out any research; but the Committee is of the opinion that encouragement should be given where there is a desire to do research as it is believed that science masters and mistresses will themselves benefit in a number of ways. In consequence, their teaching and their pupils will be better served.

COLOUR TELEVISION AT THE UNIVERSITY

Television is good enough to entertain the masses. Can it really do no more? The British Broadcasting Corporation and the staff of Guy's Hospital and Medical School combined to present a series of sixteen demonstrations, lasting just over two hours, on November 19 of last year. This was an historic occasion in more ways than one. It was the longest continuous transmission of colour television broadcast by the BBC from Alexandra Palace, and it has been the first occasion on which a university has been the initiating force. The Marconi's Wireless and Telegraph Company installed a colour television projector and a 6 ft. by 4 ft. screen at Western House in London, so that the senior staff of the hospital and medical school, as well as a large number of representatives from other faculties and other medical centres, could judge the technical performance of this British equipment. The real purpose of the demonstration was to consider whether the potential properties of colour television as demonstrated were sufficiently promising to warrant a critical trial, under practical conditions, of its applications in university teaching.

Communication—verbal, graphic, and printed—has been the vehicle of both cultural and civilising advance throughout human history. It may therefore be no more than prudent to examine the qualities peculiar to television for their possible usefulness in teaching. Any such experiment at university level is bound to influence transmissions to schools and possibly even broadcasts to the general public. It would be equally wrong to make exaggerated claims as to condemn out of hand this method of visual communication without a trial under practical conditions.

What, then, is there to test? We need to know what effect, in terms of visual experience, understanding, and learning, colour television can have on the student. Is it more effective with undergraduates or with post-graduates, is it more useful in one subject than in another? Under what circumstances, in which teaching situations, and how, would it be applied most economically? A large medical centre can be an ideal testing-ground. It represents a number of sciences: physics, chemistry, biology, anatomy, and physiology, as well as all the various medical and surgical specialities. Apart from this diversity of disciplines, a medical school is responsible for the teaching of students at various levels, technicians, radiographers, physiotherapists, and nurses, undergraduates and post-graduates. Few other university organisations possess illustration departments which can produce the diagrams, slides, and films which may be required for a full exploitation of this form of visual teaching.

It may here be of value to consider the basic properties of colour television in relation to their potential application. It can show to virtually unlimited audiences any visible phenomena. Large scenes such as bulky apparatus in a laboratory, as well as small objects, as, for instance, ants carrying their eggs, can be relayed from a location which is well beyond direct vision. High-power microscopy can be demonstrated rather better than with conventional projection microscopes. Even the function and behaviour of internal structures of the body will come within the normal experience of the student, as soon as the optical problems associated with endoscopy have been solved. Good colour is, of course, essential for the proper demonstration of a large number of events and phenomena. Two cameras may be placed in quite separate locations, as, for instance, in a laboratory and a ward. Different aspects of one subject can thus be correlated or contrasted by sequential projection or even by juxtaposition on two adjacent

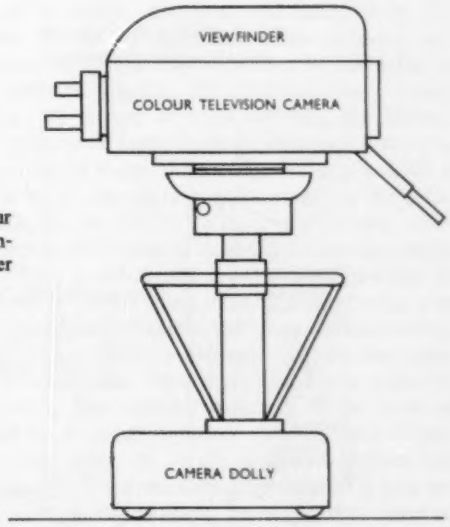


FIG. 2. Colour television camera, viewfinder and dolly.

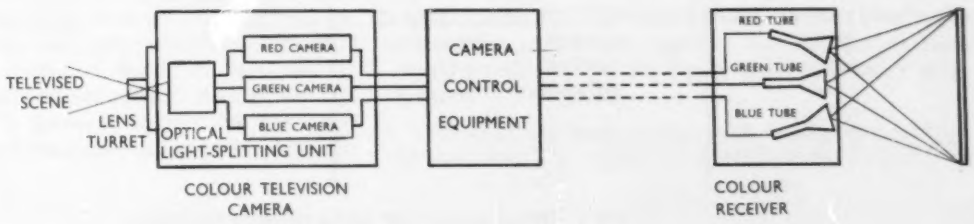


FIG. 1. Basic elements of a colour television channel.

screens. Apart from its ability to magnify for the benefit of many students, realism is possibly of the greatest potential value. Unlike diagrams, slides, or films, the televised image shows something that is happening at exactly the same moment. A two-way radio link can be used to foster audience participation. Students can ask questions which the assistant, who is in front of the television camera, can answer. His demonstration can be repeated, interrupted, and varied at the request of the lecturer, who can assess the value of such directives to his students. The lecturer will be with his students, in full control of what is being televised.

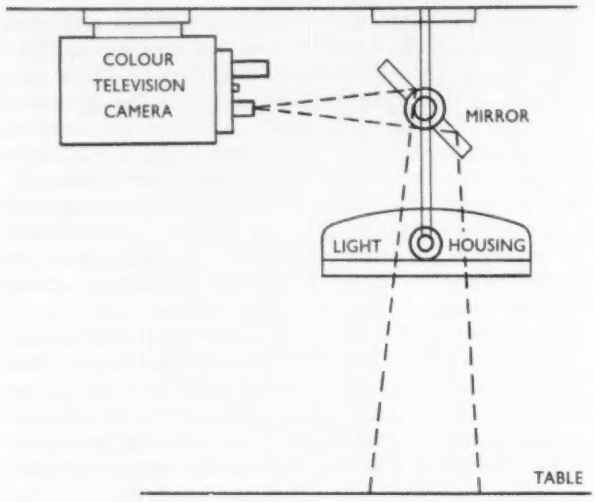


FIG. 3. Ceiling mounting for colour television camera.

It has been said that motion-picture films could be used equally well. This supposition is at fault on several counts. Few teachers would have the time to write the treatment and script, to supervise the rehearsal, shooting, and editing of the many films which would have to be made to offset all that the television camera can record. Even if sufficient film units existed to make these films, would this material be acceptable to different lecturers, would it be suitable for different audiences?

Although the colour and definition of the present system is beyond reproach, special equipment will have to be designed for teaching purposes. In black and white television, cameras no larger than the better type of amateur cine-cameras are already available. Recent French and American developments in this field have reduced the control equipment to the size of a pack which can be carried on the operator's back. Colour equipment must of necessity be somewhat more bulky. Nevertheless, it is not unreasonable to suppose that the manufacturers can devise a camera with a zoom lens which can be controlled by the lecturer. This would enable him to obtain general views and close-ups as and when he needs them. For most demonstrations the camera could occupy the position of a "favoured observer", so that a separate cameraman will not be needed.

A part of the pioneering work of Guy's Hospital and the BBC has been recorded as a sound colour film, and a booklet has been published by the Marconi Company in collaboration with the Illustration Department of Guy's Hospital Medical School. Both are available to those who wish to study the implications of colour television in greater detail.

BLACKFLIES AND BLINDNESS

Widely dispersed throughout the world is a family of small biting flies known as the Simuliidae. The larval stages are aquatic and are found attached to rocks or vegetation in swiftly flowing rivers or streams. Wherever they are plentiful, the adult flies constitute a vexing and even dangerous

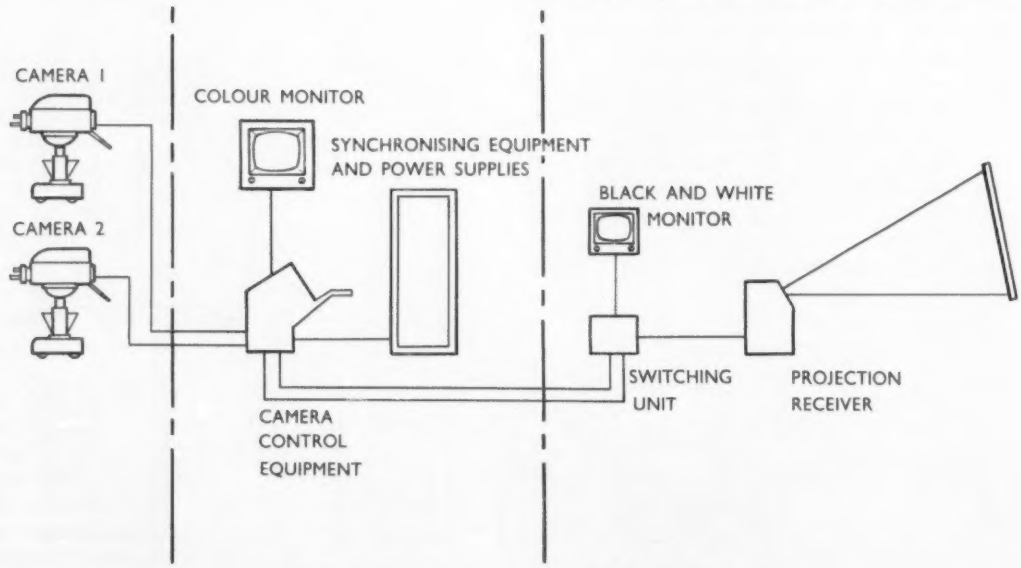


FIG. 4. Typical closed-circuit colour television installation.

scourge of man and domestic animals. With short plump bodies and a characteristic humped-back appearance, they range from 2 to 5 mm. in length, being therefore larger than midges but smaller than most mosquitoes. In Britain, where there are about a score of species, we call them "Blackflies"; but they are seldom very numerous. However, very serious swarms occur from time to time in parts of Europe. One trouble-spot is the area near the "Iron Gate" of the Danube, in Yugoslavia. Here the notorious "golubatz fly" (*Simulium columbaschense*) occasionally swarms in vast numbers, spreading over large tracts of country and killing thousands of domestic animals by the enormous numbers of bites inflicted. In North America the simuliids are known as "buffalo gnats", from their humped back. Plagues of them have been reported as far apart as the Mississippi Valley (where over a thousand mules died from their bites, in 1931) to the Canadian Arctic (where they demand continuous control measures throughout the summer near air bases and lumber camps).

As might be expected, simuliid flies are common in many parts of the tropics; furthermore, throughout Central Africa and in parts of Central America they are carriers of a particularly unpleasant disease, known as Onchercerciasis. This disease is due to minute filarial worms which are parasites both of the Blackfly and of man. The adult worms lie curled up in large wart-like nodules on the human body. When male and female worms unite, they produce large numbers of minute progeny, the microfilariae. These crawl about in the skin and can be readily detected if a tiny snip of cuticle from an infected person is examined under a microscope. When a *Simulium* fly bites an infected person it usually becomes infected with these minute worms, which then undergo development in the fly. Eventually the filariae appear in the biting proboscis of the Blackfly, ready to infect another victim. For some reason, however, serious infections do not develop in people who only suffer a few bites, because onchercerciasis is a disease of people regularly exposed to attacks of infected *Simulium*. There are, indeed, many such sufferers. The disease is widespread in West Africa and in the Northern Territories of Ghana alone, there are estimated to be half a million victims. In Central America the disease is less common, but it is believed that there are some 35,000 patients in Mexico and about 25,000 in Guatemala.

The initial stages of onchercerciasis are not serious but eventually the microfilariae invade the tissues of the eye and cause partial or complete blindness. In endemic areas, up to 5% or 10% of the population may be thus stricken. Drugs are known which kill the microfilariae and thus ameliorate the disease; but they do not kill the adult worms, so that the microfilariae eventually reappear. Sometimes the adult worms can be removed by excision of the visible nodules on the patient.

An alternative mode of attack on this disease is to destroy the Blackflies which transmit it from person to person. In the past twelve years there have been a considerable number of experiments on the control of Blackflies, especially in Canada, where the insects do not transmit disease, but are a severe nuisance. It is generally agreed that the most feasible method of widespread destruction of Blackflies is to attack the larvae, which are very sensitive to minute traces of insecticide in the water. It has been found that one-tenth of a part per million of DDT in the water, maintained for fifteen to thirty minutes, destroys all larvae of *Simulium*. It has been found a compartively easy matter to apply DDT emulsion to a stream or river and thus destroy all the larvae downstream for a considerable distance. One such trial in Canada eliminated all larvae for a distance of over 100 miles down the Saskatchewan River. In certain parts of Africa where the breeding sites of *Simulium* were isolated it has been possible to exterminate the fly in a particular locality. An early successful example of this was the eradication of *S. neavei* from the Kodera district of Kenya in 1946. In the intervening years a distinct improvement in the health of the local people has been established in the reduction of onchercerciasis. More recently, the extermination has followed in other districts of Kenya, involving territory of some 15,000 square miles, so that the whole of the colony is now free of this disease vector.

The situation in Kenya is somewhat more favourable than in other parts of Africa, where complete extermination of the flies does not seem to be feasible at present. This is because the breeding sites are widely and continuously disseminated and the adults can fly distances of at least twenty-five miles. Therefore any stream cleared of larvae can immediately be reinfested by adult flies from other areas laying eggs in it. This means that regular treatments over a wide area are necessary to keep down the numbers of flies, and this is by no means easy in territories containing numerous streams and rivers in rough terrain, ill-supplied with roads.

The whole question has been recently investigated in the field in Ghana by teams organised and financed by the British Empire Society for the Blind. This philanthropic body was concerned by the high incidence of blindness in Ghana and northern Nigeria, the principal cause being onchercerciasis. At a cost of some £40,000, the Society equipped an ophthalmic team to study the medical aspects and an entomological team to investigate the possibilities of prophylaxis by fly destruction. The report of the entomological team, led by Dr G. Crisp, has now been published.* It gives a full account, in non-technical language, of the extent of the problem and is copiously illustrated to show the nature of the breeding sites. These streams and rivers in the Volta basin, characteristically vary enormously in flow, being strong floods in the rainy season and mere trickles in the dry season. One of the important unsolved problems posed by this seasonal variation, is the mode of survival of the fly in the dry months. On the basis of two years' work in the field, the report outlines a provisional control scheme, which would cost about £20,000 a year for some three years. It is greatly to be hoped that some of these proposals will be adopted by the new Ghana Government. In the meantime a control trial on a somewhat smaller scale (about 1200 square miles) has been progressing successfully in northern Nigeria. Results of such trials should greatly improve the health and well-being of many Africans.

* "Simulium and Onchercerciasis in the Northern Territories of the Gold Coast", by G. Crisp, 171 pp., Lewis & Co., London, 1956.

UNDERGROUND CONSTRUCTIONS IN SWEDEN

HUGH PITT

In 1940 Sweden embarked on a series of underground works dictated mainly by the need to defend herself against possible attack from Nazi Germany or the Allies. For some years her Government had been considering "going underground"; a number of pilot schemes had proved successful, but there is little doubt that the tremendous potential, both for civil and military use, of her underlying strata of igneous rock was not fully appreciated until the end of the Second World War.

With a solid rock strata just below the surface or outcropping, the problems of surface buildings in towns always involved heavy blasting or drilling. Eleven years ago the "Swedish Method" of rock drilling was made possible by the Atlas-Copco Company in Stockholm.

A NEW DRILL

With the advent of the new drill technique it became in fact cheaper to build below ground than above. The secret of this technique lies mainly in the design of a new drill operated by compressed air. The drill tip is flushed by water through the hollow drill steel and the drill's moving parts are lubricated simultaneously by a fine oil spray. At the same time, the drill is connected to a pusher leg with a claw foot, operated by compressed air.

The development of an extremely tough tungsten-carbide drill bit which is slotted into the drill steel, combined with the pusher leg, allowed a rate of drilling never before attained: something in the nature of 15 in. a minute. The pusher leg, fed by the same air-pipe which feeds the revolving, hammered steel, allows the drill to operate by itself for long periods, once it has been started by the driller and initial penetration of the rock has taken place.

By regulating the amount of air being fed to the pusher leg, the driller can keep his drill perfectly aligned with the steel; bore-holes up to 30 ft. in length become commonplace. However, the most significant feature of the new drill is its light weight of only 90 lb.; the whole drill, pusher leg and various steels, can be carried easily by one man.

DRILLING METHODS

For the drilling of large tunnels, a three-tiered drilling "jumbo" is backed up to the drill face by lorry. The rig is then firmly jacked and the lorry driven off. The system allows teams of five or six men on each tier to drill with comparatively ample elbow-room. Drilling and blasting can be carried out in one 8-hr. shift. In the other two shifts "mucking-out" is done with mechanical grabs and 20-ton Euclid trucks. The system is suitable for all types of rock.

In most tunnelling projects air and water are piped direct from the tunnel mouth. Flexible connexions are moved up with the jumbo after each mucking-out operation, and after a team has laid the new length of permanent system. For roof drilling in confined tunnels, Atlas-Copco, in co-operation with Sandvik Coromant drill steels, have developed a flexible drill up to 31·6 ft. long which can be pushed into the bore-hole and then connected to the drill. Special drills are also used for roof-bolting where this is necessary.

SHELTER, CAR PARK, AND SEWAGE PLANT

The effectiveness of this Swedish method can be seen in the construction of the Katarinaberget in Stockholm. This is the three-deck bomb shelter and car park with room for 20,000 people standing, or 5000 people to live.

In February 1952 the first charges of blasting powder were fired at the two ends of the proposed shelter. By

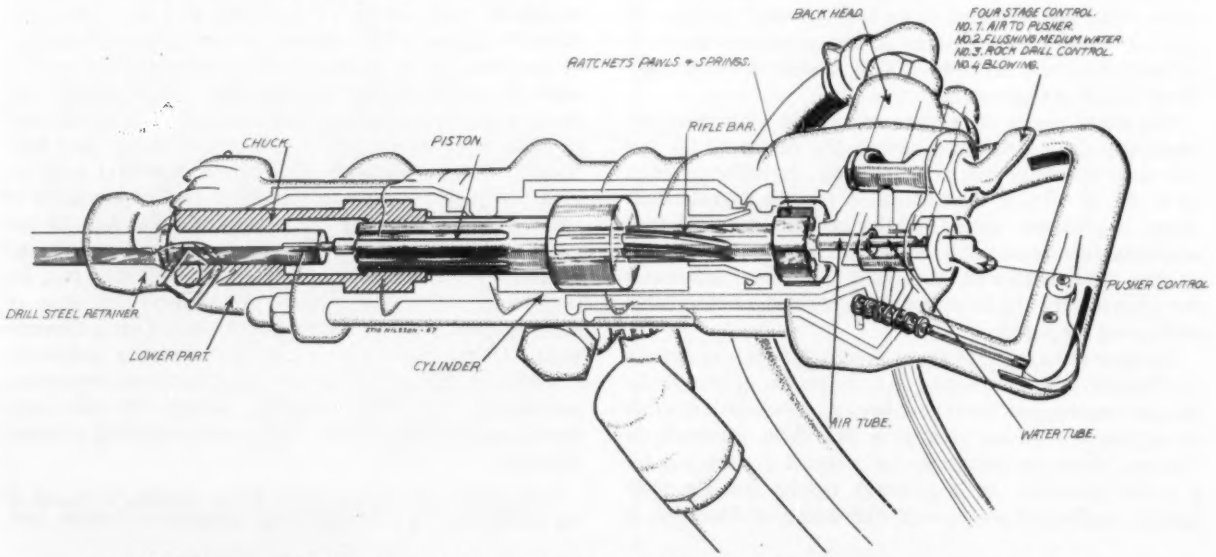


FIG. 1. This cut-away drawing shows the components of an an Atlas-Copco lightweight one-man-operated rock drill.

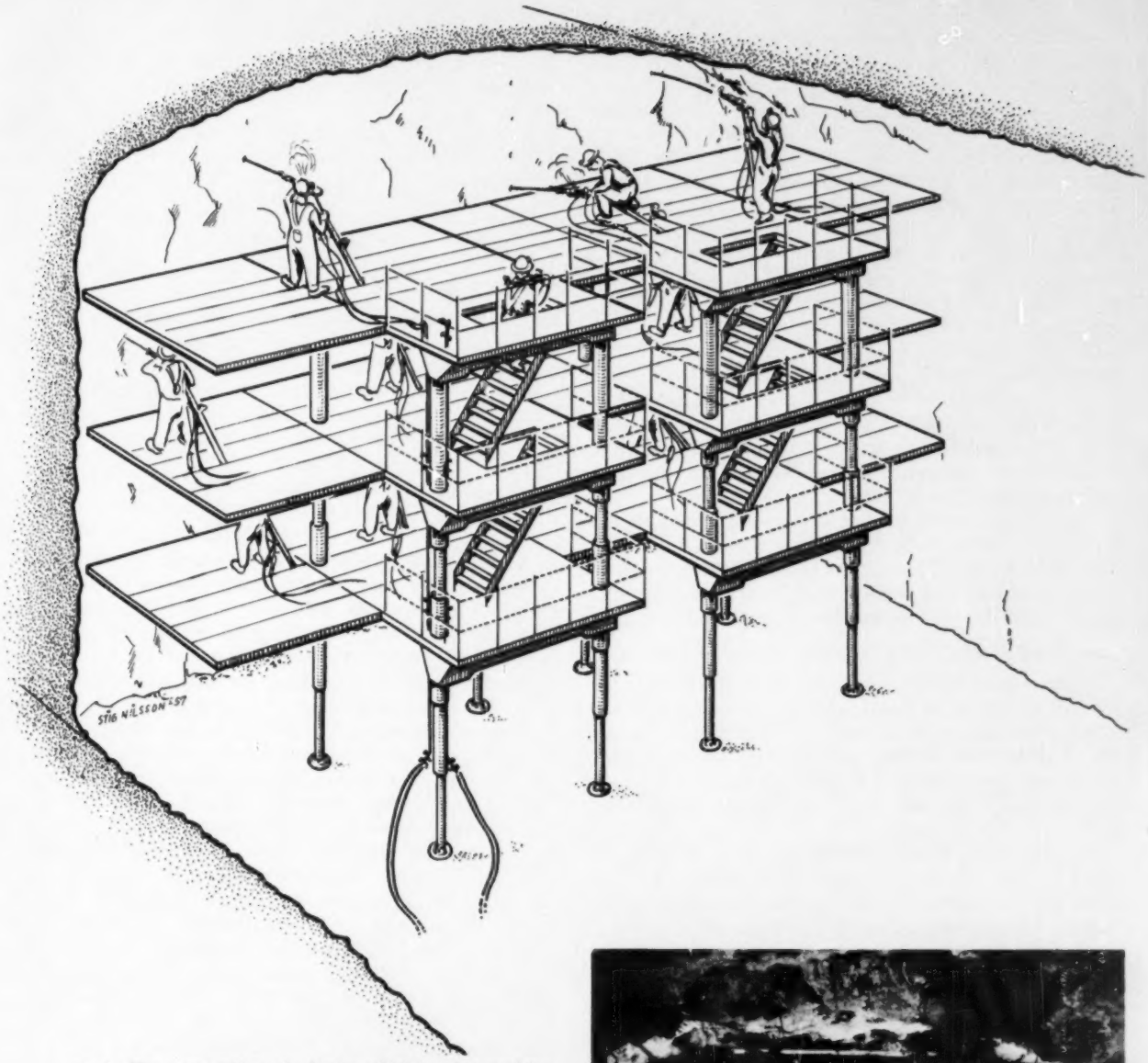


FIG. 2. The construction of a jumbo which is being used for the Swedish method of drilling.

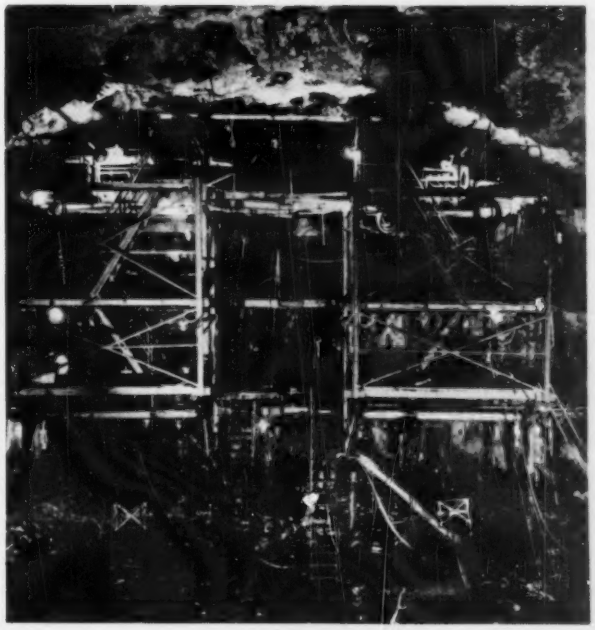


FIG. 3. The Harrsele Project. A top heading of 1410 ft. sq. (130 m^2) is first being driven in the discharge tunnel at which operation the jumbo in this photograph is used. Twenty men with an equal number of Atlas-Copco rock drills BBE 41 WK with pneumatic pushers achieve an advance of 24 ft. per round. After drilling, the jumbo is loaded on two Euclid trucks and moved to a suitable place.

November of that year the two blasting gangs met half-way. A year later the enlarging blasting works had finished and the construction work started. By January 1957 the entire work was finished and ready for its civil and military purposes.

In the event of attack, the shelter can be used by 20,000 people. Special refrigerators reduce the air temperature of all three stories to a comfortable level, and 130 fans keep the air moving. The same air duct system, of course, extracts exhaust fumes and keeps the place at a constant temperature when the shelter is used as a garage. There are two petrol stations (one at either end), a drive-in bank, motor showrooms, and a service bay.

In most cases where there is need for a many-storied structure below ground, a cave is blasted out first and then a reinforced concrete structure is built. The Stockholm city archives were built in this way. They are housed in a concrete five-storied structure in a vast cavern cut from solid rock, and it is possible to walk round the outside in the space between the structure and the rock.

The side of a sheer escarpment in Stockholm was chosen for the site. The tunnelling was undertaken from the road-level at the top of it. The face of the escarpment, however, remained intact. The main Stockholm sewage plant also lies some 100 ft. below the surface of the ground.

AIRCRAFT FACTORY AND HANGARS

The enormous SAAB aircraft factory is 150 miles to the south of Stockholm at Linkoping. It is almost completely underground and its machinery is protected by up to 200 feet of solid rock. During a recent visit to Sweden the author was permitted to visit this factory as well as the Tullinge Royal Swedish Air Force fighter station, also south of Stockholm.

Tullinge's hangars are underground along with certain repair facilities necessary for an air force station. There is room for four fighters or fighter-bombers of the Lansen type in each hangar, the entrances being protected by heavy doors and specially staggered blast-bays which would absorb the air blast from a hit directly outside the hangars. There are probably a number of similar stations elsewhere in Sweden; Tullinge, responsible for the air defence of the capital itself, showed a high degree of readiness.

Because of the difficulties of jet exhaust in confined spaces, the aircraft stand ready and connected to towing vehicles. These vehicles move the aircraft from the hangars in the event of a "scramble"; the pilot starts his engine just outside and then drops the tow-bar on the taxi-way at the same moment as the vehicle pulls clear and the aircraft takes off.

UNDERGROUND HARBOURS AND HYDRO-ELECTRIC PLANTS

The possibility of surprise attack is constantly in the minds of Swedish planners and they seem determined to hold out in the event of a prolonged war. To this end they have also constructed ship caves in the sides of the fjords which ring the Baltic coastline. They are each capable of holding destroyers, submarines, and torpedo-boats: the backbone of the Royal Swedish Navy. There are also underground ship repair and dock facilities, the author was told, though he was not permitted to see anything of them.

In the ship caves the vessels are safe against air attack by day, and the confined waters of the Baltic make it a simple thing to conduct effective surprise attacks at night. The vessels may then be left safe inside again by daylight.

The Swedish State Power Board also embarked on a series of underground hydro-electric schemes some years ago. At Harsprånget, in the north, some 6000 miles of bore-holes were drilled in extremely hard rock with record-breaking speed. The advance for each round fired was some 20 ft. with a tunnel area of 2045 sq. ft.

The Swedish Method of drilling is used almost universally today. The three-tiered jumbo technique was used in Volturno, Italy, for example, and although it was necessary to drill through extremely variable limestone strata, the deadline was beaten by five months. Another drilling record was established at Vinstra, in Norway, where this system was used. There the main tunnel for a hydro-electric scheme became the longest continuous water-tunnel in Europe, 15½ miles through the heart of a mountain. Perhaps other countries will also be influenced by these techniques of underground construction, projects which grew out of the dictates of military and defence needs, but were conditioned by the fact that construction above ground is generally more expensive.

FIG. 4. Service facilities at the entrance to the Katarinaberget, one of the underground garage-shelters in Stockholm. *Left foreground:* self-service pumps where petrol is a fraction cheaper than at normal pumps. Drivers help themselves to petrol and the amount of fuel is registered inside the cash office where the motorists pay. *Right foreground and background:* entrances to the three underground stories. These entrances are closed by automatic glass-panelled doors which open when a car passes over the rubber press band in front of them.

FIG. 5. A Swedish destroyer inside one of the ship tunnels which are cut into the rocky fjords. The apparent funnel structure above the destroyer in the centre of the picture is a telescopic fume extractor which is lowered over the funnel once the ship is moored. This enables full steam to be maintained. The building of these shelters is made fairly simple by the fact that the sea around Sweden is tideless; the coastline itself is protected against heavy swell by off-lying barriers of islands.

THE CERN 600 MeV SYNCHRO-CYCLOTRON

ARNE LUNDBY

European Organisation for Nuclear Research, CERN, Geneva

High-energy accelerators for nuclear particles have undergone such rapid development during the last decade that the synchro-cyclotron, from being foremost in this class ten years ago, has now to share its place with several other high-energy machines. High cost and engineering difficulties limit the energy to which synchro-cyclotrons can accelerate protons to about 1 GeV (1000 million volts). What it does not achieve in energy, however, the synchro-cyclotron achieves in intensity.

While synchrotrons may eject particles with tens of GeV energy, the intensity of the produced particle beams is generally so low that it is difficult to do more than exploratory investigations with them. The existence and qualitative behaviour of heavy mesons, hyperons, antiprotons, and antineutrons are at present the main research topics of synchrotrons.

The synchro-cyclotrons produce only light mesons as "new" particles. The intensity of the meson beams is on the other hand so high that we may do quantitative experiments, that is, experiments in which we may investigate the detailed features of the interactions between mesons and nuclei.

A number of synchro-cyclotrons are in operation in U.S.A., U.S.S.R., and Europe. The largest one, until recently, was located at the Doubna Research Institute near Moscow. It ejects 680 MeV protons with a current of about 0·2–0·3 μA.

In May last year a 700 MeV synchro-cyclotron started operation at Berkeley in California, U.S.A.

The CERN synchro-cyclotron went into operation at the beginning of August last year. It delivers 600 MeV protons. When designed it was the largest in the world, but now it

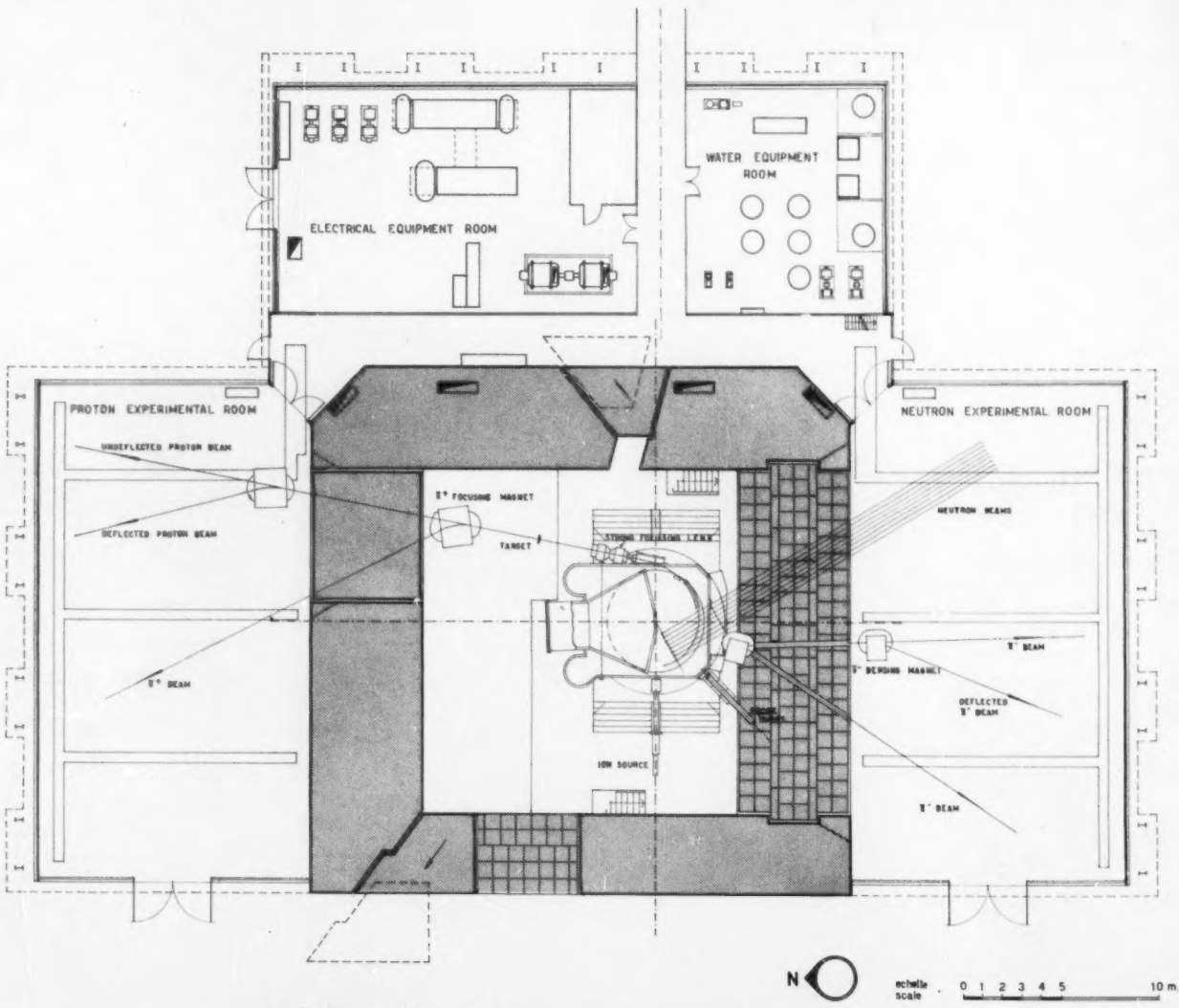


FIG. 1. General layout showing the various beams leaving the cyclotron.

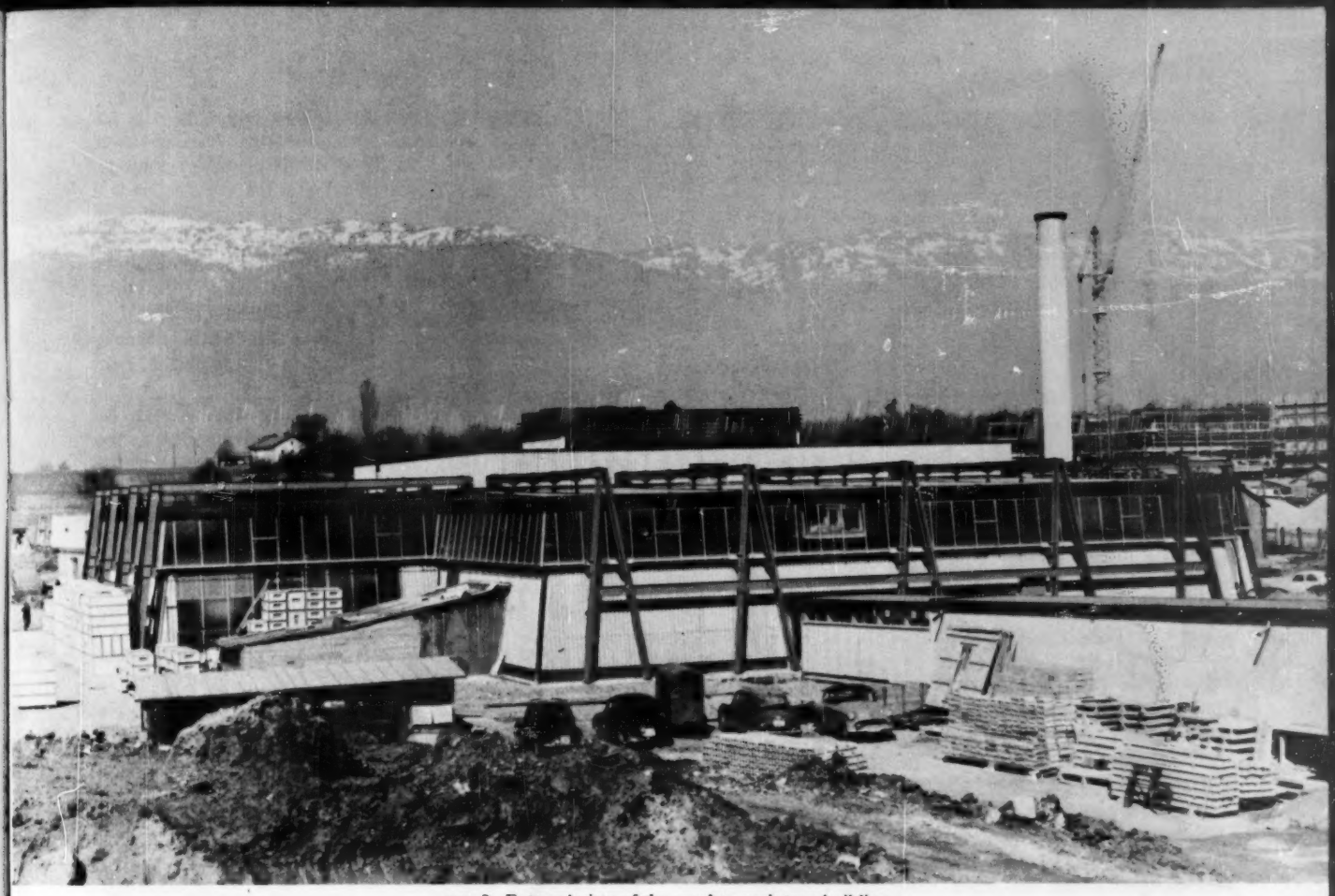


FIG. 2. External view of the synchro-cyclotron building.

ranks third. Both the American and Russian machines are modifications of lower-energy synchro-cyclotrons, permitting a shorter construction period.

A future competitor to the synchro-cyclotron may be the spiral-ridge cyclotron. This is a modification of the cyclotron with spiral ridges of iron added to the pole pieces of the magnet. The shape of the magnetic field makes it possible, at least in theory, to accelerate particles to hundreds of millions of volts with conventional cyclotron techniques (frequency modulation not required). The full run of tests of the spiral-ridge principle, applied in a machine in the 500–700 MeV region, will probably take several years.

PARTICLE BEAMS

A cylindrical electromagnet, where the magnetic field is kept constant in time, forms the bulk of the synchro-cyclotron. The ions to be accelerated are introduced near the centre of the machine in the vacuum chamber which is placed between the pole pieces (see Fig. 1). A D-shaped electrode in the vacuum chamber accelerates the ions by a few kilovolts per revolution. The ions move along spiral orbits between the pole pieces. The radii of the spiral turns are directly proportional to the momentum of the ions. When the ions reach the periphery of the magnet they enter a region where the magnetic field has been distorted. The ions are here forced into radial oscillations which drive them out to a magnetic channel, which, in turn, guides them out of the machine.

The protons will emerge from the CERN synchro-cyclotron with an energy of 600 MeV. The current of protons before extraction is of the order of one-tenth of a microampere on the average. Similar synchro-cyclotrons in the West deliver currents of 1 to 2 μA., and we also hope to attain this value after some experimentation. The external proton beam has an intensity of about 3% of the beam circulating inside the machine. In the case of the CERN synchro-cyclotron the external 600 MeV proton beam will consist of about 55 pulses per second with some 10^9 protons per pulse. Each pulse will have a duration of a few hundred microseconds. On leaving the synchro-cyclotron the protons will enter a strong focusing magnetic lens which converges the beam. When the beam strikes matter, a number of high-energy neutrons, pi-mesons, mu-mesons, electrons, and gamma rays are produced. Our problems are to find out how these particles interact with each other and with matter in general.

EXPERIMENTS

According to current theories of nuclear structure, neutrons and protons are the building-blocks of nuclei with pi-mesons as the main link between them. The pi-mesons are 273 times heavier than the electrons but nearly 7 times lighter than the protons and neutrons. Pi-mesons do not exist as free particles within nuclei but are constantly transferred from one nucleon to another. The transfer time is too short to identify the pi-mesons as a unit in the nucleus. We are by no means sure that only pi-mesons are

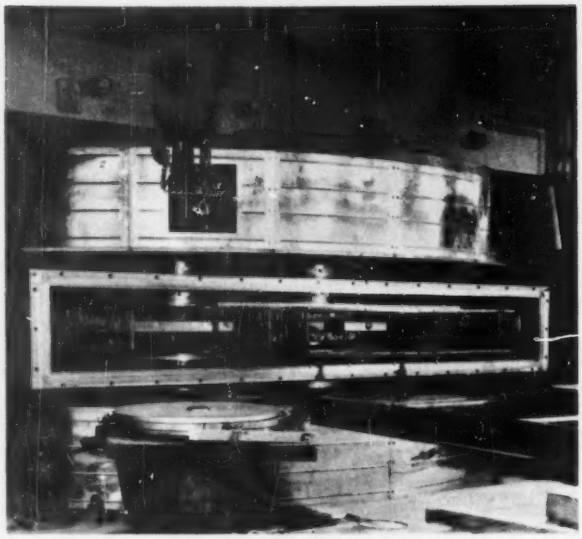


FIG. 3. The synchro-cyclotron magnet.

responsible for nuclear forces. Furthermore, only fragmentary knowledge of the way in which pi-mesons interact with protons and neutrons is available.

The higher the energy of the pi-mesons, the closer they are capable of approaching nuclei and thus feel the intimate forces acting on them. With the 600 MeV protons from the CERN synchro-cyclotron, pi-mesons are produced with kinetic energies up to 400 MeV. The intensity falls rapidly for energies above 300 MeV. The most accurate experiments will therefore be done with mesons from 150 to 300 MeV.

The pi-mesons are produced as the protons strike a target of carbon, for example, placed either in the extracted proton beam or in the beam circulating inside the machine. In the latter case the mesons are bent out and to some extent focused in the fringing field of the synchro-cyclotron magnet. In order to select the energy of the mesons they are passed further through a deflection magnet before reaching the experimental apparatus.

One of the most fundamental problems in present-day physics is to find out how pi-mesons interact with protons. We mentioned previously how protons were used to produce mesons. Now we use the mesons to bombard protons, this time in the form of a liquid hydrogen target. The mesons scattered from the hydrogen are measured with scintillation crystals viewed by photomultipliers. Since the phenomena to be observed occur rapidly, the electron registering techniques involve handling of electrical pulses of 10^{-9} second duration. The measurements of the angular distribution of scattered mesons are finally fed into electronic calculating machines which treat the data so that the results can easily be used to interpret the physical events.

Pi-mesons have a mean lifetime of $2{\cdot}6 \times 10^{-8}$ second. If they are left undisturbed they disintegrate into mu-mesons. Mu-mesons are 207 times heavier than electrons, and decay in turn into electrons with a lifetime of $2{\cdot}2 \times 10^{-6}$ second. These two successive decays have recently been shown to proceed differently according to whether the processes are described in a right-handed or a left-handed co-ordinate system* (non-conservation of parity), and they are not symmetrical with respect to an interchange of the charge state of the particles (non-conservation of charge conjugation). One of the consequences is that the mu-mesons and electrons are polarised, that is, their spins point either in the direction of motion or in the opposite direction. These qualitative features have been established, but the processes are not known in enough quantitative detail to permit a unique theoretical description. The mu-meson beam growing out of the pi-meson beam from the CERN synchro-cyclotron will therefore also be used in experiments to help clarify these phenomena.

A number of other problems will be studied with the help of the CERN synchro-cyclotron, problems such as the interaction of protons and neutrons with nuclei, and the mechanisms governing the production of mesons. In the past, emphasis has shifted among particular types of experiments, and this will no doubt continue in the future. Experience has shown that experiments which at one time appeared to be of little interest turned out later to be of fundamental importance. On the other hand we have to

* Thus we cannot say that the phenomena proceed in the same way whether we look at them directly or reflected in a mirror.

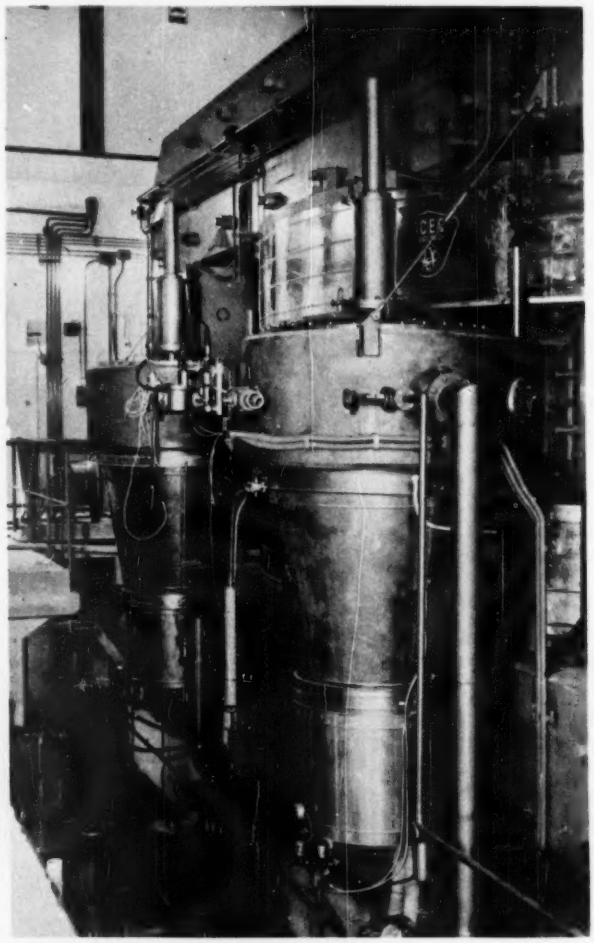


FIG. 4. The pumps mounted to the vacuum system chamber between the pole pieces of the magnet.

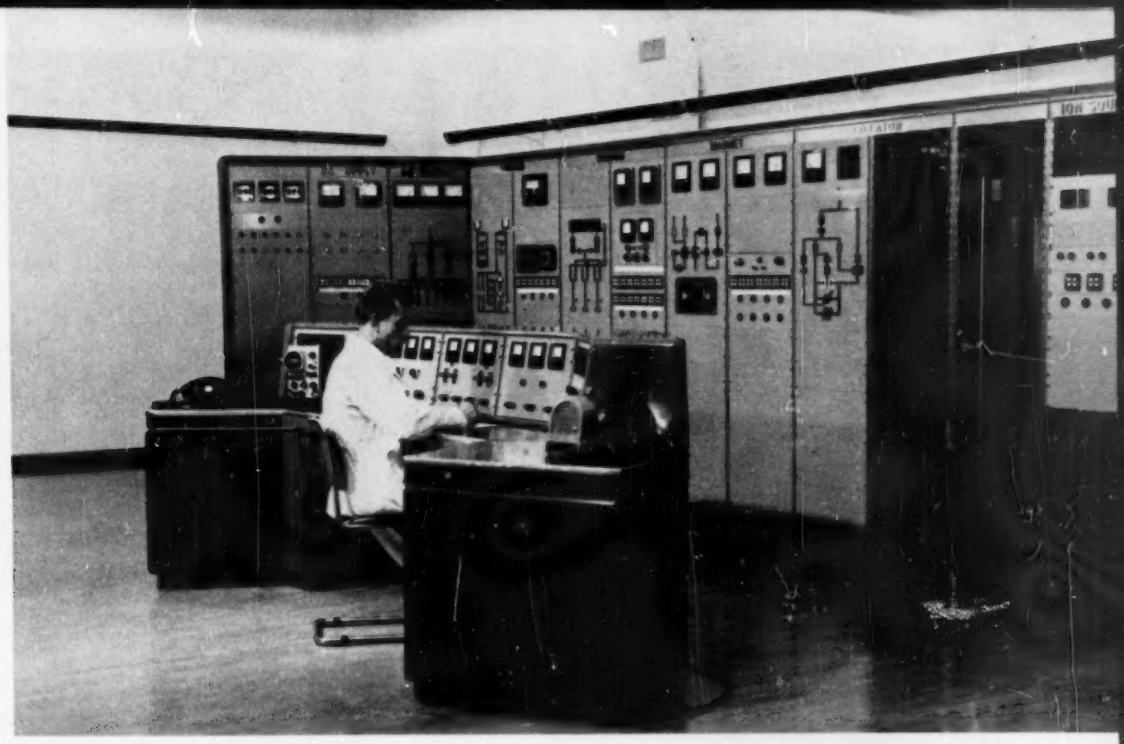


FIG. 5.
The control room.

choose among the multitude of possible experiments because of the limit set by the intensity of particle beams and the running time of the machine.

There will be a staff of thirty to forty physicists and fellows in CERN experimenting with the synchro-cyclotron. Teams of physicists from the different Member States of CERN may also plan experiments in their respective countries and come to Geneva with their apparatus to do the experiments with the synchro-cyclotron.

DESIGN OF THE SYNCHRO-CYCLOTRON

The cost of the CERN synchro-cyclotron, including buildings and salaries of personnel, amounted to somewhat less than 2 million pounds sterling. The construction of the building for the machine was started in the second half of 1954. The various parts of the machine have been made in different countries: the magnet in France, the generator for the magnet current in Switzerland, the coils in Belgium, the vacuum chamber in Sweden, the pumps in Germany, the radiofrequency system in the Netherlands.

The machine is located at the core of the synchro-cyclotron building, a T-shaped symmetrical structure. The supports of four overhead cranes form the skeleton of the walls and the roof. Heavy baryte concrete shielding walls, 4 to 5·8 m. thick, surround the machine. The particles are directed into the experimental halls on either side of the machine through adjustable openings in the shielding walls. The two openings may be closed with stacks of two-ton baryte concrete blocks, placed on hydraulically operated platforms. Slits may be left between the blocks to allow the beams to pass.

A fifty-metre-long corridor connects the machine to the control and counting rooms.

The iron of the electromagnet for the synchro-cyclotron weighs 2500 tons. The pole pieces have a diameter of 5 m. and the gap between them decreases from 45 cm. at the centre to 36 cm. at the periphery.

To excite the magnet a current of about 1800 A. is fed through two aluminium coils connected in series, with 333 windings per coil. The power dissipated is 800 to 900 kW.

The stainless-steel vacuum chamber is connected to two diffusion pumps with a pumping speed of 12 m.³/sec. each at 10^{-4} mm. Hg pressure, and three mechanical pumps with a pumping speed of 170 m.³/hour each. The pressure in the tank is $3 \cdot 10^{-6}$ mm. Hg when the ion source is not working and $6 \cdot 10^{-6}$ mm. Hg when operating.

The accelerating electrode or Dee is connected to a variable condenser through a section of a transmission line. Two types of variable condenser have been made. One is a tuning fork and the other a rotating condenser.

The condenser goes through a cycle about 55 times per second. The frequency range required for the acceleration of protons is from about 29 to 17 Mc/s. A water-cooled grounded-grid triode is used as oscillator with an input power of about 50 kW. The maximum voltage on the Dee will vary between 12 and 4 kV during the acceleration. The high-frequency system with the tuning-fork condenser is at present connected to the synchro-cyclotron and is being tested.

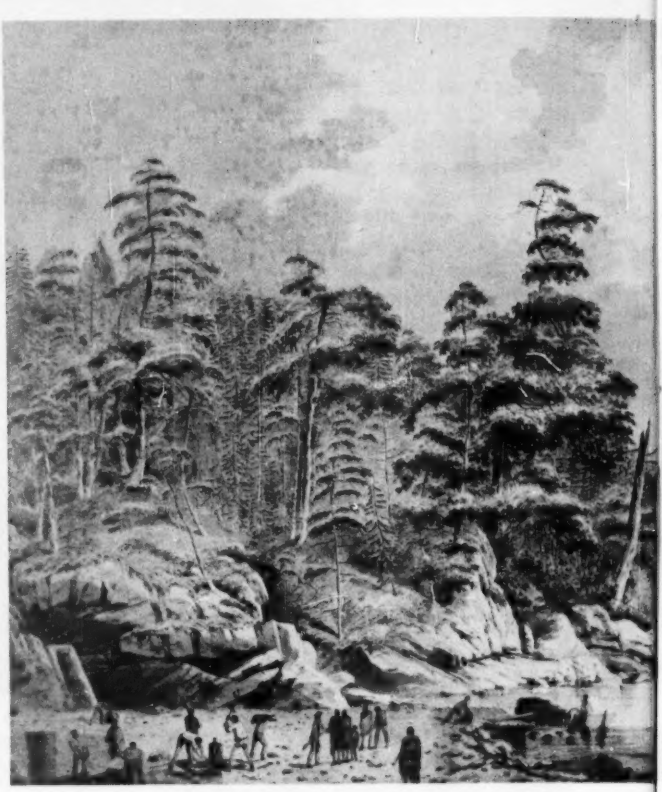
Only minor items are left to be completed on the machine. During present operation a reasonably intense beam of protons is circulating inside the machine (of the order of 0·1 μA.). The magnetic channel for the deflection system has been lined up and the machine was operating with an external proton beam by the end of last year.

The director of the CERN synchro-cyclotron division is Prof. W. Gentner from Germany. The project was started under Prof. C. J. Bakker from the Netherlands, who is now the Director-General of CERN.

By the end of last year the division numbered about fifteen physicists and twenty-three fellows (life-holders), who will have the assistance of theoretical physicists from the CERN theoretical group in planning and evaluating experiments.

"DISCOVERY" SHIPS OF THAT NAME

COMMANDER C. H. WILLIAMS, R.N.R.(Retd)



Discovery is obviously a suitable name for ships engaged on voyages of exploration, hydrographic surveying, oceanography, or any other scientific work afloat. It is not surprising, therefore, that many vessels have borne the name, although not all of them have been used for such work.

Search in various records and official lists has resulted in finding no fewer than twenty-five ships that have been named *Discovery*, dating from 1602 to the present day. There may have been earlier ships of the name of which no record remains, for it would have been a likely choice during the great age of geographical discovery.

The two vessels of the name at present afloat under the British flag are both Government-owned. They are HMS *Discovery* (an auxiliary barque) and the Royal Research Ship *Discovery II*. As is usual when there are two ships of the same name in commission at the same time, the one which was more recently built or named is given the distinguishing number.

SEARCH FOR THE NORTH-WEST PASSAGE

(1) First on our list is a small vessel described as a barque of between forty and seventy tons (records differ). She was owned by the then newly founded London East India Company at the beginning of the 17th century, and she has probably the greatest claim to fame of any of the *Discoverys*. She sailed from London in 1602 under the command of Captain George Weymouth, in company with a vessel called the *Godspeed*, on a voyage to seek the North-West Passage. They penetrated into Davis Strait and sighted the western shore and a channel which may have been the one to be later known as Hudson's Strait. Ice prevented their further advance, and they returned to England.

A few years later, in April 1610, this same little ship, under the command of Henry Hudson, sailed from England on another attempt to discover a north-west passage to the Indies. Hudson managed to pass through the ice-strewn strait and into the great bay that bears his name. They wintered in a creek in James Bay, in the southern part of Hudson's Bay. In the following spring some of the crew mutinied and seized the ship. Hudson and his son and seven sick men were turned adrift in a small boat and were heard of no more. After great hardships and dangers a few of the crew reached Plymouth in the *Discovery* in September 1611.

In 1612 this *Discovery*, this time commanded by Captain Ingram, was again in Hudson's Bay in company with the *Resolution*, in Thomas Button's expedition. They reached as far as latitude 65° N in the channel known as Roe's Welcome. (It is a coincidence, as will appear in these notes, that over a century and a half later two other ships named *Discovery* and *Resolution* were to sail on one of Captain Cook's voyages of exploration.)

The stout little ship was next on a voyage to Labrador in 1614, and the following year was again in Hudson's Bay and into Fox Channel, with Robert Bylot as master and William Baffin as pilot or mate. (Bylot was one of the few survivors of Hudson's last voyage.) Again, in 1616, with the same master and pilot, the *Discovery* was once more in the North-West, and it was on this voyage that the great discovery of Baffin's Bay was made. They reached the high latitude of 78° N. Baffin was one of the outstanding navigators of his day and had made many voyages to the North. He was of a scientific turn of mind and was a keen and accurate observer. His notes on tides and his observations of latitude are in agreement with modern findings, and he was one of the first to attempt to determine longitude at sea by means of lunar distances.

OTHER "DISCOVERYS" OF THE PAST

(2) Another small vessel of the same period was named *Discovery*. She was a pinnace of about twenty tons and was with two other ships, the *Susan Constant* and the *Godspeed*, in the English expedition to establish a colony in Virginia in 1606. The famous Captain John Smith was in this venture, the 350th anniversary of which was commemorated by a ceremony on December 20, 1956, at the Virginia Settlers Memorial at Blackwall on the Thames, from which place the ships had sailed. (In 1610 this

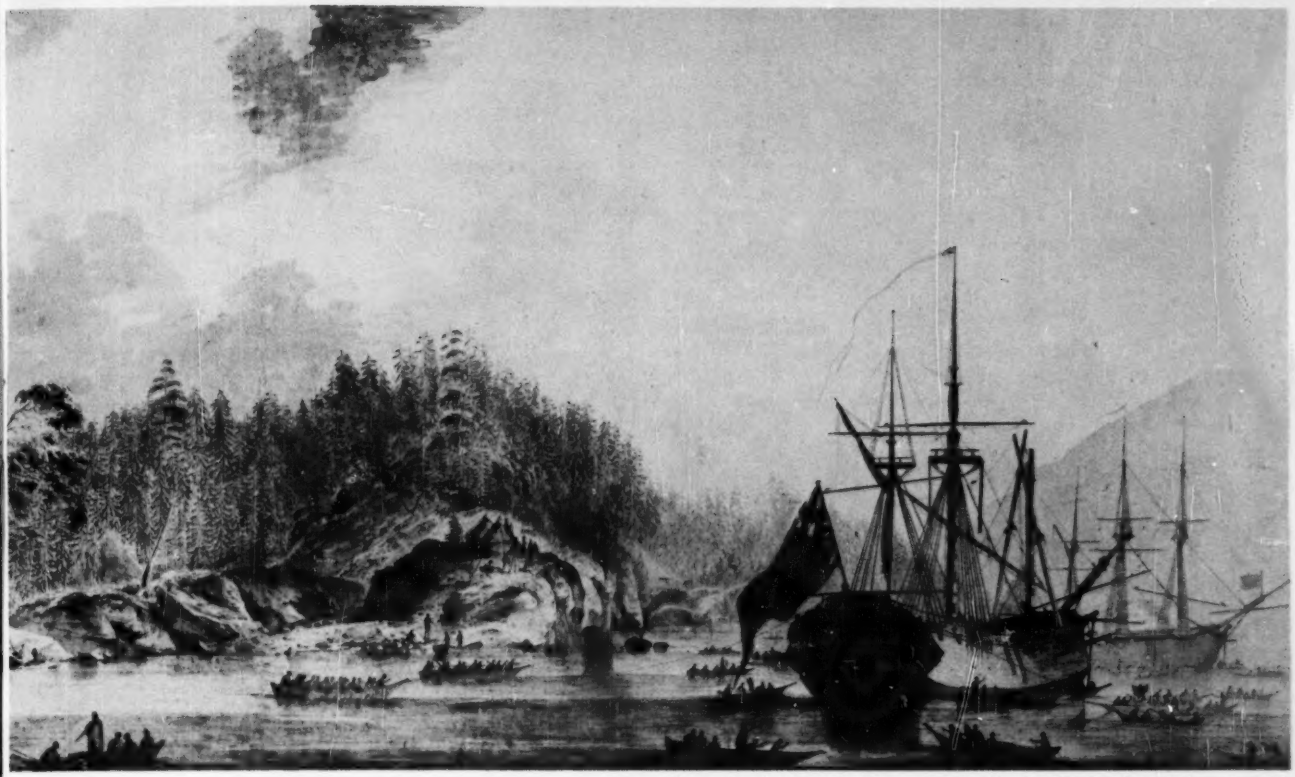


FIG. 1. The *Resolution* and *Discovery* (Cook's) in Nootka Sound, March 1778.

Discovery was again in the James River, Virginia, so she was obviously not the same vessel as Hudson's *Discovery* of that year.)

(3) In 1626 a merchant ship named *Discovery*, of about 240 tons and thirty guns, was owned by the East India Company.

(4) A ship named *Discovery* was purchased for the Navy of the English Commonwealth in 1651. She was a Fourth Rate of 200 tons and twenty guns, in the fleet under William Penn in the West Indies in 1654, and was present at the taking of Jamaica in 1655.

(5) Their Majesties' brig *Discovery*, of seventy-seven tons and eight guns, was in the Royal Navy in 1692.

(6) Another *Discovery*, of 250 tons and twenty guns, was owned by the East India Company in the year 1700.

(7) In 1711 a dogger, a two-masted vessel something like a ketch, was captured by the Royal Navy and was added to the fleet as HMS *Discovery*.

(8) The Hudson's Bay Company sent out from London in 1719 their sloop *Discovery*, of forty tons, Captain Barlow, in company with a vessel called the *Albany*, Captain Vaughan, on an expedition under Mr James Knight, to continue the search for the North-West Passage and also to try to discover a rich mine of copper which Eskimos had reported. The ships sailed into the northern part of Hudson's Bay and both were lost with all hands. Many years later, in 1767, some remains were found on Marble Island by the Hudson Bay Co.'s sloop *Success*.

(9) In 1741 the Admiralty dispatched two ships, HMS *Discovery*, a pink,* Captain Moor, and HMS *Furnace*, Captain Middleton, late of the Hudson's Bay Company, to carry out exploration to the north of Hudson's Bay on yet another attempt to find the long-sought North-West Passage. They wintered at the Hudson Bay Co.'s factory at Churchill River, and in 1742 proceeded north into Roe's Welcome and discovered Wager Bay and Repulse Bay. Further progress being impossible that season because of the ice, the ships returned home.

(10) On the last voyage of exploration made by the renowned navigator Captain James Cook, R.N., in HMS *Resolution*, during the years 1776–9, he was accompanied by HMS *Discovery*, Captain Charles Clerke, R.N. This latter vessel was a barque of 299 tons and eight guns, and had been built at Whitby in 1774 as the *Diligence*. She was purchased by the Admiralty in 1776 and renamed *Discovery*. The voyage was a continuation of Cook's exploration of the Pacific Ocean and also an attempt at the North-West Passage from its western end. After visiting the west coast of North America, the ships passed through Bering Strait and explored and charted the northern coast of Alaska until prevented from further progress by ice in latitude 70½° N. Later in this voyage Captain Cook was killed by the inhabitants of Hawaii.

(11) Another HMS *Discovery*, sometimes confused with the above vessel of Cook's voyage, was a sloop-of-war, of 337 tons and sixteen guns, bought by the Admiralty while she was being built on the Thames in 1780. This ship was also employed on exploration work in the Pacific from 1790 to 1795, under the command of Captain George Vancouver, who had served as a midshipman under Captain Cook on the fateful last voyage. Captain Vancouver explored and carefully surveyed the Pacific coast of North America from latitude 41° N to latitude 60° N. This sloop

* A pink was a ship with a very narrow stern. The word does not describe the rig, such as barque, brig, etc., but merely a peculiarity of hull-design.

FIG. 2. A vessel of the type of *Discovery* (14). A ten-gun brig. (Sketch by the author.)

Discovery was in the Medway during the mutiny at the Nore in 1797, and was present at the battle of Copenhagen in 1801.

(12) *Discovery*, a ship-rigged American privateer, of twenty guns, was owned in Boston, Mass., in 1781.

(13) A British merchant brig *Discovery*, of 241 tons, was trading to the West Indies in 1792.

(14) The East India Company had a brig named *Discovery*, of 303 tons and ten guns, built to their order at Howrah, on the River Hooghly, in 1811. She appears in a list of the Company's Marine, what was virtually the Indian Navy, in 1823.

(15) In Vancouver, B.C., in 1863, a merchant schooner of forty tons, was built and named *Discovery*.

(16) The next *Discovery* was the wooden barque-rigged steamer of 556 tons, built at Dundee as a whaler in 1873 and originally named *Bloodhound*. She was bought by the Admiralty the following year and renamed *Discovery*. In May 1875 she sailed, in company with HMS *Alert*, on an exploring expedition under the command of Captain G. S. Nares, R.N., to North Greenland and the Polar Sea via Smith Sound, with orders to reach the North Pole if possible. This was the last big Arctic expedition undertaken by the Royal Navy. During their stay in the Far North a sledging-party from the ships reached what was until then the farthest North that had even been attained: latitude 83°20′ N. A higher latitude would no doubt have been reached but for the incidence of that bane of polar exploration, the dreaded disease, scurvy. In all, 58 men out of 122 suffered from it, and four of them died. Discovery Harbour, in the north of Ellesmere Land, was named after this ship. The ships returned to Portsmouth after an absence of two years. The *Discovery* was then converted to a naval store-ship and remained so until 1903, when she was sold out of the Service and reverted to her old name of *Bloodhound*. She appeared in Lloyd's Register under that name until 1918.

(17) In 1874 a wooden barquentine *Discovery*, of 416 tons, was built at Port Discovery, Washington, U.S.A., and was registered in San Francisco, California.

(18) A trading ketch *Discovery*, of 718 tons, was built at Hull in 1879.

(19) In 1882 a schooner named *Discovery* was built at Green's Bay, Newfoundland, and was registered at St John's, Newfoundland.

(20) A merchant ship, a steel screw steamer of 1916 tons, was built at Sunderland in 1888 and was named *Discovery*. She was owned by the Rowland and Marwood Steamship Co., of Whitby, and she was the largest of the vessels in this list of the same name.

(21) In 1889 another merchant ship, a small screw steamer of 209 tons, was built at Port Townsend, Washington, U.S.A. She was lost in 1903 .

CAPTAIN SCOTT'S "DISCOVERY"

(22) Next in the list is what is usually thought of as Captain Scott's *Discovery*, one of the two British vessels of the name still afloat. She is moored alongside the Embankment in King's Reach in the River Thames, or London River, as seamen call it.

This ship was specially built in 1901 for the National Antarctic Expedition, which was organised by the Royal Geographical Society and the Royal Society. In appearance she was similar to the *Discovery*, ex-*Bloodhound* (16), being a barque-rigged steamer of 736 tons, built on the general lines of the Dundee whalers of the latter part of the 19th century. She was commanded by Captain R. F. Scott, R.N., on his first Antarctic voyage, from 1901 to 1904. This, of course, was a truly scientific expedition. As well as the main purpose of exploration, much work on such subjects as geology, oceanography, and meteorology was carried out.

On Scott's return from the Far South, the ship was bought by the Hudson's Bay Company, and she traded to

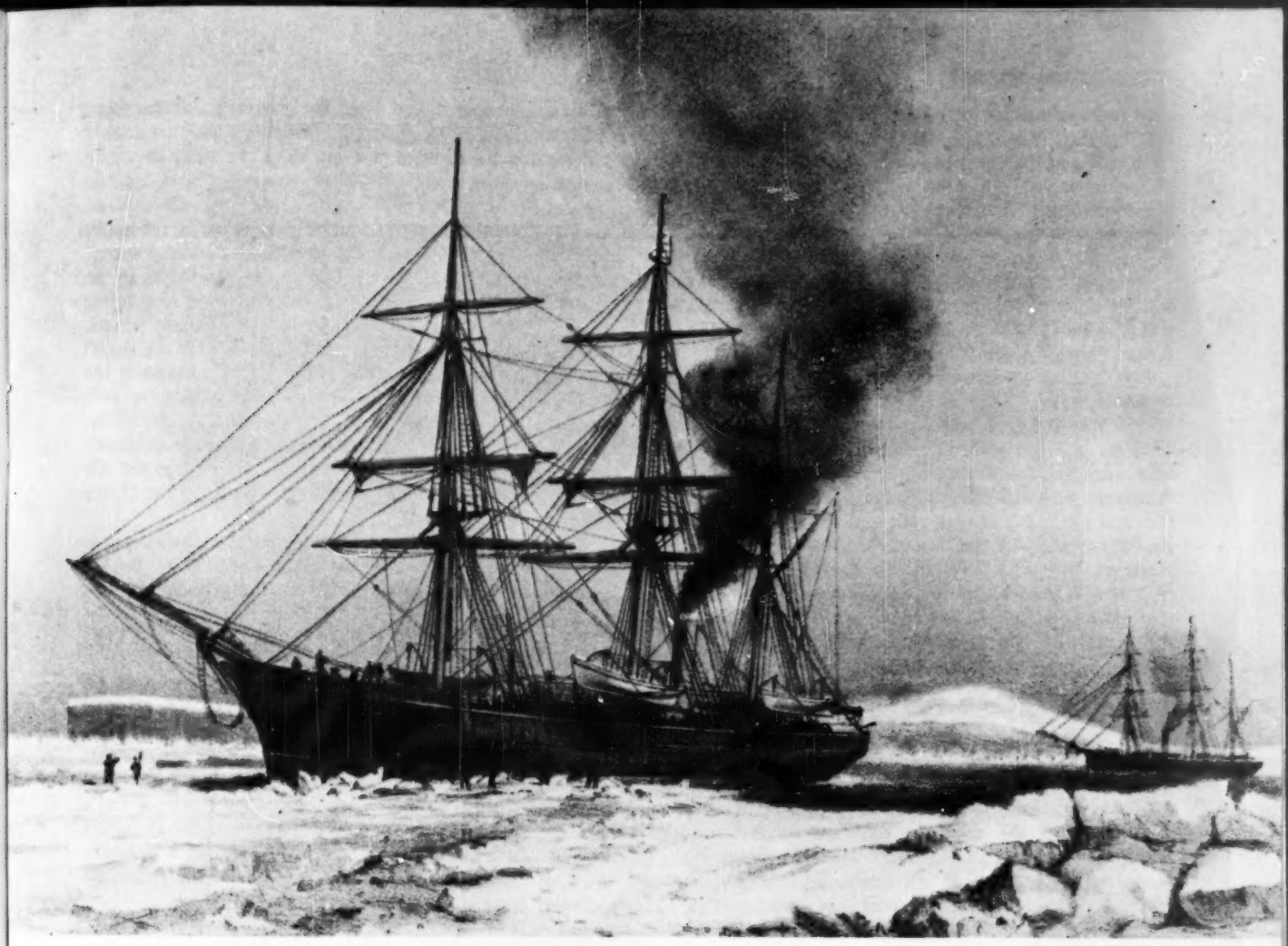


FIG. 3. A reproduction from Captain G. S. Nare's coloured lithograph of *Discovery* (16) while ice-bound in the Polar Sea.

FIG. 4. Captain R. F. Scott, R.N.; with Mr George Murray, Chief Scientist; and Mr Shackleton, on the bridge of *Discovery* (22). The photograph was taken during the ship's first Antarctic voyage, 1901–1904.

their posts in the Canadian Arctic until 1912, when she was laid up. She was taken up for war service from 1914 to 1916, and was then returned to the Hudson Bay Company, in which service she remained until 1923. The Crown Agents for the Colonies then purchased her for use by the Discovery Committee on whaling research and hydrographic survey work in the Southern Ocean.

She returned to England in 1927, and in 1929 sailed again for the Antarctic with Sir Douglas Mawson's expedition, which lasted until 1931, when she returned to the London River. There she has remained ever since.

In 1937 the Boy Scouts Association took her over as a stationary training ship for Sea Scouts. During the Second World War she was used as a river emergency station. In 1955 her upkeep proved too costly for the Scouts and there was some talk of her being scrapped. Fortunately, the Admiralty came to the rescue and took over the old ship. She was given a thorough refit and she lies alongside the Embankment flying the flag of the Admiral Commanding Reserves. Unfortunately, although she still has the masts of a barque, she has no yards, a defect which spoils her appearance—at least to a seaman's eye.

(23) In 1911 a small motor vessel built at Tacoma, Washington, U.S.A., was named *Discovery*.

THE RESEARCH SHIP "DISCOVERY II"

(24) Still actively employed afloat is the Royal Research Ship *Discovery II*. She was built at Port Glasgow in 1929 and is a steel screw steamship of 1062 tons, 234 ft. long, 36 ft. beam, and 20 ft. moulded depth. This vessel is one of the very few ships ever built specially for scientific work. She and Scott's *Discovery*, Nansen's *Fram*, Peary's *Roosevelt*, the Swedish *Albatross*, and a few fishery research ships are about the only ones.

Primarily intended for whaling and oceanographic research in Antarctic seas, *Discovery II* is a stout and reliable vessel, capable of remaining at sea for long periods (she has a maximum cruising range of 10,000 miles) and with ample spares and gear for carrying out her own repairs. To protect her from pack-ice her hull has double plating over the forward part and along the water-line. She is not, however, designed to deal with heavy pack-ice. At present her usual complement is fifty-two, which includes six scientists. There are two main laboratories on the upper deck, and, of course, gear for deep-sea sounding, water-sampling, nets for collecting plankton, and so forth. In the years before the war she was mainly employed in whaling research and other scientific work in southern waters. During the war she was an armed patrol vessel in the Royal Navy. Since the war she has made one long cruise in the Indian Ocean and in Antarctic seas, and she is now employed by the National Institute of Oceanography, mainly in the North Atlantic. She has also been chartered to the Admiralty for special research work and to the Air Ministry for a short while as a relief for one of the Ocean Weather Ships.

(25) The last *Discovery* we have been able to discover is a wooden trawler, built in California in 1936 as the *Sea Rover* and later renamed. She was registered in Los Angeles.

THE TWENTY-FIVE

Of the twenty-five *Discoverys* listed above, eight were employed on voyages of exploration, during which some of them carried out other scientific work as well. Nine of the total were ships of the Royal Navy (if we include one that was in the navy of the English Commonwealth), either built as such or taken up for special service. The East India Company owned four ships of the name, and the Hudson's Bay Company had two. The remainder were ordinary merchant ships, except for one which was an American privateer.

All were small ships by modern standards; some of them very small, but many of them made long, and what must have been for the crews, arduous voyages. Much scientific knowledge of the oceans has been collected by some of the ships named *Discovery*.

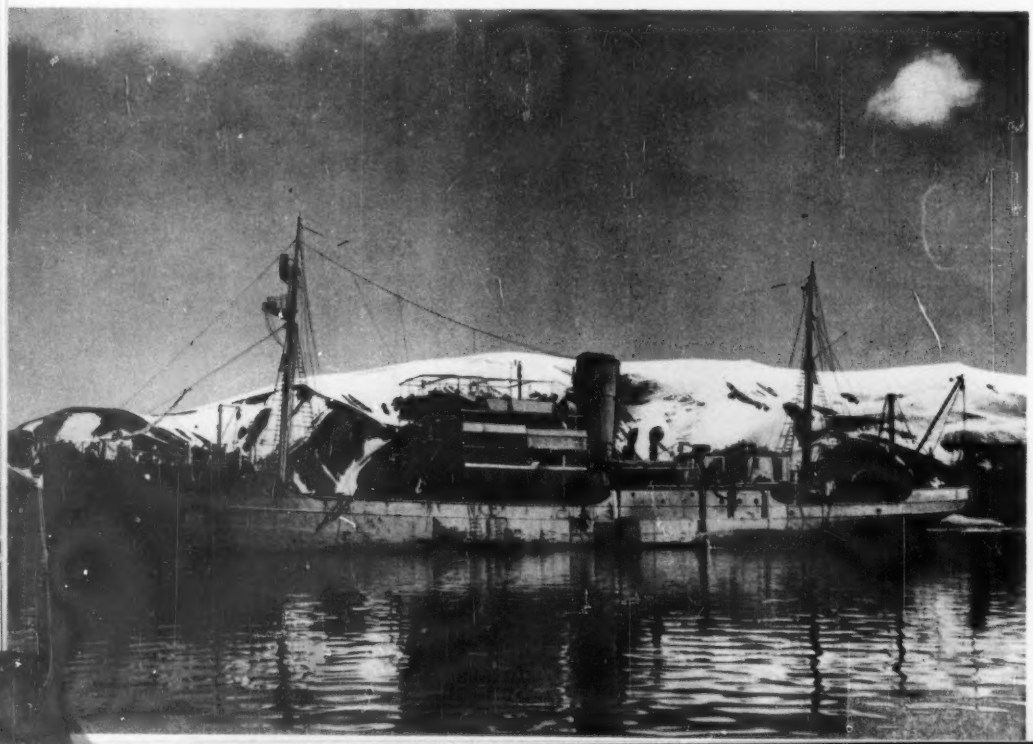


FIG. 5. R.R.S. *Discovery II* in Antarctic waters.

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HYDRO-ELECTRIC ANTHROPOLOGY

A Study of the work of the Mexican Federal Electricity Commission and its human implications

IRENE NICHOLSON

The Mexican Federal Electricity Commission kindly afforded the author full facilities for visiting the great hydro-electric system known as "Miguel Alemán", named after the past President of the Republic of Mexico.

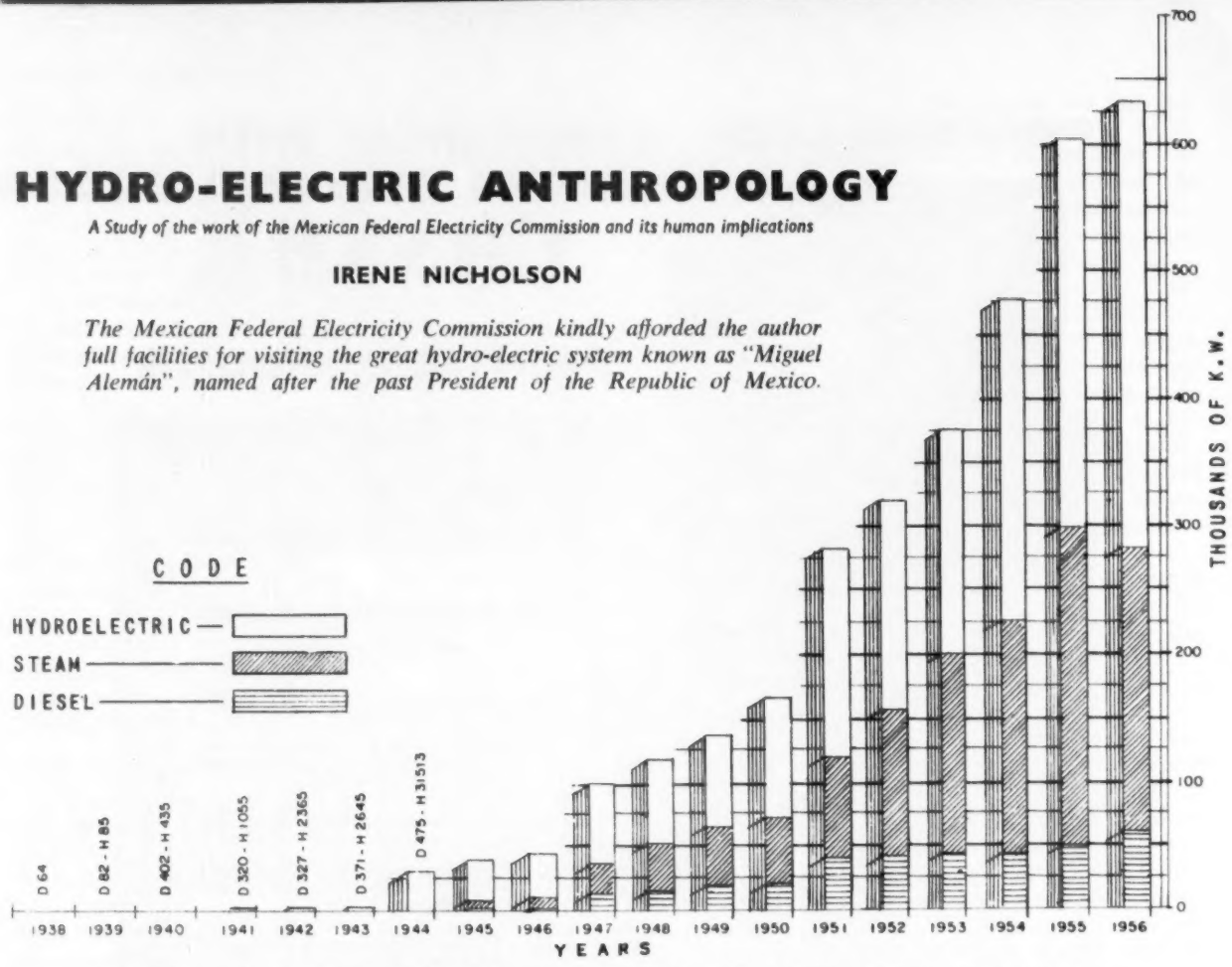


FIG. 1. Diagram showing the growth rate of electric power in Mexico between 1938 and 1956. (*All photographs by courtesy of the Federal Electricity Commission of Mexico.*)

THE DEMAND FOR ELECTRIC POWER

Travelling by car the 110 miles from Mexico City, the chauffeur—a Mexican—had the wireless turned on, and advertisement "plugs" were a constant reminder of all the new industries with insatiable appetites for electric power.

Mexico, with a population growth-rate higher than any in the world, and with its centre of gravity shifting from agriculture to industry, is becoming more and more dependent on electric power for its economic subsistence. Every few moments, as one drives, the rhythmic Mexican music is interrupted by advertisements for this or that locally manufactured commodity: radios, beer, soft drinks, newsprint and the newspapers themselves, cloth and clothing, stomach pills and sedatives, bicycles, machinery of all kinds, concrete—all the complex needs of an urban and sophisticated society, and of a peasant population fast becoming consumers.

The Miguel Alemán System sends electricity in to the Federal District of Mexico, where the capital city of nearly 4 million inhabitants consumes much of the load. The rest is distributed to smaller towns and villages in seven surrounding States: Mexico, Hidalgo, Tlascala, Guerrero, Michoacán, Puebla, and Vera Cruz. The peak load is at present 600,000 kW, but the demand is growing by 13% a year. The daily consumption is 12 million kWh, and this, too, is increasing at the rate of 8% yearly.

During the last thirty years the number of consumers of electricity in the whole country has risen from 130,000 to 613,000. Half the country's population is still without electricity, but this fact has to be assessed against the growth-rate and against the very simple requirements of the peasant villages. The figures for the rise in the number of consumers includes both private and industrial users, the former having risen from 217,000 in 1940 to 490,000, and the latter from 66,000 to 123,000.

FINANCE

To cope with the demand, the original Mexican Light and Power Company (financed by British, Belgian, Canadian, and U.S. funds) found itself inadequate. So the Federal Electricity Commission was formed, and between 1947 and 1952 it was able to borrow nearly 85 million dollars from the International Bank for Reconstruction and Development, the Import Bank of Washington, and other U.S. sources. Even so, the present plants are already inadequate, and more are being planned and built as fast as funds will allow. There will, however, probably have to be some restriction on the use of electricity in the near future.

Apart from external loans, the Federal Electricity Commission is financed by an electricity tax, and by grants from the Federal Government. The former amounted in 1952 to

3 million U.S. dollars, the latter to 24 million. With these funds, plus the U.S. loans, Mexico has increased her generating capacity from 31·4 million kW in 1944 to 309·8 million in 1952. The map (Fig. 1) shows the approximate position of the Miguel Alemán scheme in relation to the whole Republic. Fig. 2 shows the growth-rate of electricity.

THE MIGUEL ALEMAN SYSTEM

The Miguel Alemán System of reservoirs and plants is situated across a mountain divide south-west of Mexico City. The area covered is roughly 28 × 34 miles. This is rugged territory; to English readers, accustomed to the Lake District, the Scottish highlands, or the relative compactness of the Swiss Alps, it is difficult to give an idea of the size and sweep of the landscape. Until recently it was uninhabited except for small peasant settlements; and puma, coyote, iguana, and other wild beasts had their haunts undisturbed. Two pumas are known still to be prowling about the lowest plant, Tingambato, and these have been hunted but without success.

Until the hydro-electric scheme was put into operation there were no lakes here. Now three large and seven smaller lake-reservoirs have been formed, making use of the valleys and cup-formations in the land. Advantage has been taken of heights varying from 8600 to 2250 ft. above sea-level to harness the water for power. Plants can be extended still lower in future, or spaced between those existing. Seven rivers feed the reservoirs. There are five plants already in operation and others projected. There are approximately 40 miles of tunnel and as many again of canals. About 125 miles of new road, mostly on curves or steep gradients, had to be opened up to serve this whole area and its encampments.

The scheme is shaped like a great Y (Fig. 5), the two arms joining at the regulating reservoir of Colorines, where the central offices are situated and where there is a guest-house for engineers who come from all over the world to see what must be one of the most daring enterprises in modern Latin America.

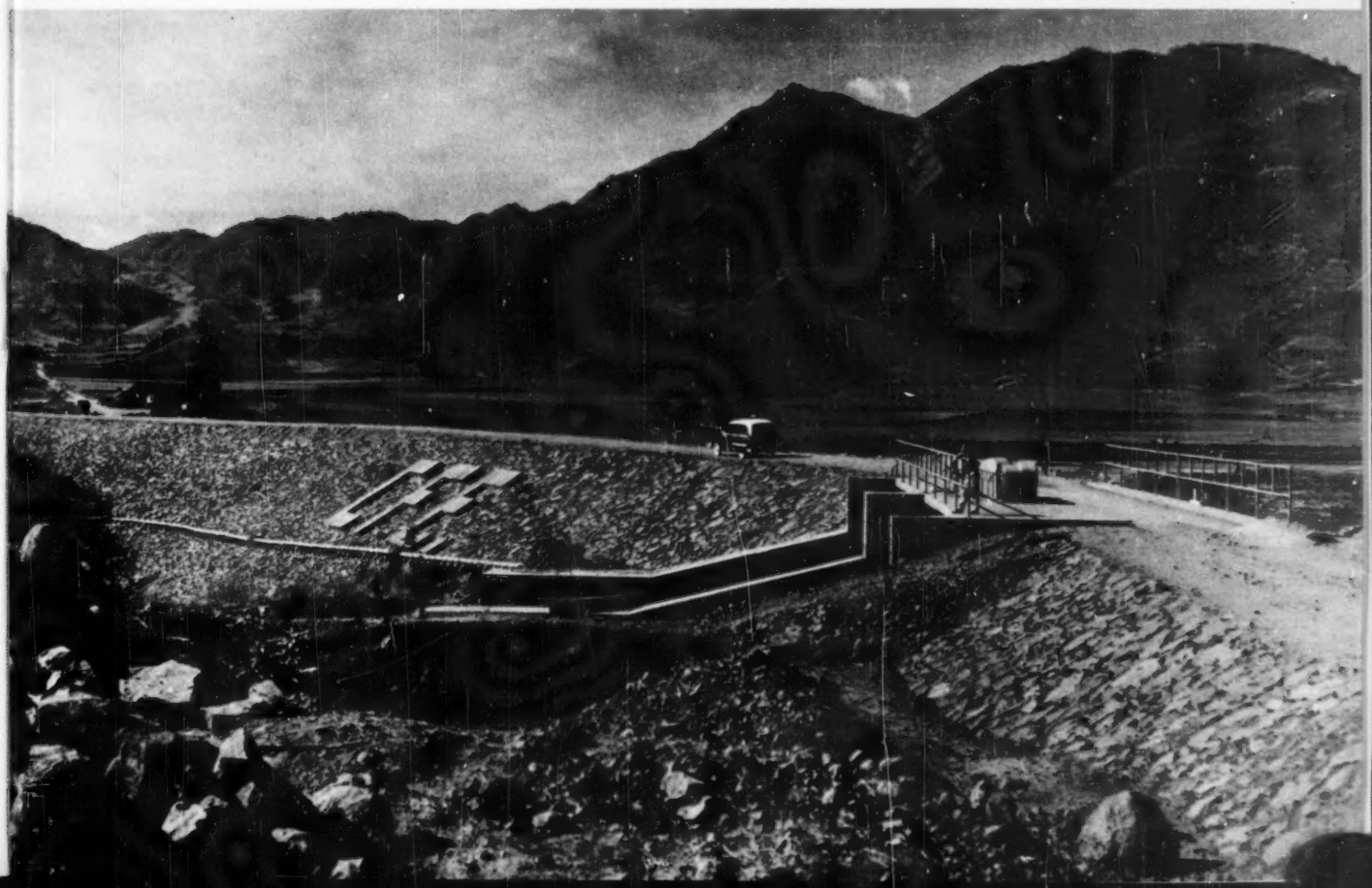
The most important arm of the Y is fed principally from the Villa Victoria reservoir, which stands 8600 ft. above sea-level and has a capacity of 210,000 cu. m. From here the water is conducted by penstock pipes with three syphons, four tunnels, and various bridges and canals) to the Ing. Hector Martinez d'Meza plant at 6897 ft. This is the only plant using a Pelton-type impulse turbine—a type based fundamentally on the old vertical waterwheel, with the water hitting cups or blades and pushing the wheel. All the other plants in the system use the Francis-type turbine with a horizontal scrollcase.

The turbine at the Ing. Hector Martínez d'Meza plant has six jets, which can work separately or simultaneously; and there is said to be only one other similar turbine in existence.

From this, the highest plant, the water continues down into the great reservoir of Valle de Bravo, with a capacity of 400 million cu. m., and then by penstock to the Durazno plant, 5580 ft. above sea-level. The tunnel bifurcates to feed two turbines, each of 15,200 h.p.

From Durazno the water goes to the relatively small regulating reservoir of Colorines, with a capacity of 2 million cu. m. Colorines is the juncture of the two arms of the Y, and here water is received also from the Tuxpan reservoir

FIG. 2. The Tuxpan dam.



away to the north-west, at 5750 ft. above sea-level, with a capacity of 20 million cu. m. The water proceeds by penstock to the El Bosque reservoir, with a capacity of 220 million cu. m., at 4500 ft., and thence by a circuitous route to Colorines, by tunnel and canal.

Close to the Colorines reservoir is the Durazno plant, from where water goes by penstock to Ixtapantongo, which is by way of being a show plant, with a very fine building. Below this plant is another regulating reservoir, with a capacity of 2 million cu. m.

The next plant lower down, Santa Barbara, is fed by two tunnels which join in an immense syphon bringing the water across a spectacular gorge. Below Santa Barbara the water flows into the Santo Tomás reservoir (capacity 8½ million cu. m.). From this point until the lowest plant, at Tingambato, the water moves entirely underground through tunnels, apart from the single intervening reservoir, Pinzanes. The dam wall at Pinzanes must be nearly 100 ft. high and about 1000 ft. across. The road from Santa Barbara to the terminal rises and falls continuously through mountains that seem to have been crushed by some primeval volcanic disturbance.

Above Tingambato there is an oscillating well, and the water drops down by penstock to this final plant, which lies in a suffocating hole that traps all the tropical heat. The plant itself is built into the mountain, and the approach is by a short tunnel. At the end of the tunnel is a mural, the ubiquitous Mexican art-form from the most ancient times. (This—not by one of the best-known modern artists—shows a figure who must be the god of lightning extending his arms right and left, embracing factories, cornfields, and peasants. The sun is behind him, and he carries thunderbolts in his hand.)

Tingambato is the only underground plant in Latin America, and the biggest air-conditioned plant in the world; but the air-conditioning is still in process of being installed, and after a few minutes, as we climbed up and down the four stories built in the mountain, our clothes stuck to our backs.

In this series of five plants there is machinery from many parts of the world, from: Allis-Chalmers, Oerlikon-Zürich, B. Maier, Westphalia; Brown-Boveri, Milan; Neyrpic, Grenoble. All the plants in the system have sub-stations with outdoor self-cooled, monophase transformers. Electric power is raised from 13,200 volts to 150 000 volts before being transmitted by three lines of pylon, each of six cables, to the Federal District. The reader may remember the aesthetic objections that were raised to running pylons across the Severn valley in the 'thirties. These in Mexico, which follow more or less the road contour, blend surprisingly well with the landscape. From a distance they look as if some gentle, if gigantic, spider had laid its web across the volcanic upheavals. They are already an integral part of the flowery landscape, where asters, daisies, golden-rod, convolvulus, lupin, and a thousand more colourful blossoms mingle with the pines in the heights, the fields of maize and sugar lower down. At one point a retired politician has planted a farm of avocado pears, and the slopes about the hydro-electric scheme are luxuriant with banana, mango, Ceiba (*Eriodendron occidentale*), and Colorín (*Erythrina americana*). The water of the newly created lakes shines a khaki-green from the reflection of the wooded slopes.

PERSONNEL

The personnel is Mexican, from the engineers down to the watchmen and road-menders. In charge of the network of plants and reservoirs is a graduate in engineering from Mexico's Polytechnic, Enrique Sivelli. He carries about with him a walkie-talkie and is continuously issuing orders —not only about the technical working of the plants, but also instructions for the welfare of his men, permission for photographers to pass, and a hundred other details. He drives the dangerous curves with one hand on the wheel, brakes to avoid a stray donkey, presses the walkie-talkie button with the other hand, makes rapid decisions, and talks to guests, all simultaneously. He would like time for photography and archaeological studies, but his responsibilities do not give him much opportunity. These details are included because such men as Ing. Sivelli are the technical experts on which modern Mexico depends—and there are too few of them. His workers rely on him not only for technical decisions but also for discipline and even for moral example. The burden is heavy, but Mexican universities and technical institutes are turning out many more men of this calibre in the present generation, and soon the technological manpower of the country will be greatly improved.

ANTHROPOLOGICAL IMPLICATIONS

The presence of all this modern equipment and the engineers to run it, and all the changes that have resulted in the landscape, have altered the peasants' way of life considerably. The floors of the reservoirs were once rich land for sugar, and on the slopes above Santa Barbara there are now the ruins of a factory that used to refine the sugar on the spot. The cane that still grows on the slopes above the reservoirs must now be sent to the town of Toluca, about half-way between Colorines and Mexico City.

As a compensation for this loss of land, Valle de Bravo has become a tourist centre, with a colony of British and American boating enthusiasts who hold regattas and fishing competitions. The peasants, too, are able to supplement their diet with small tunny.

Around the offices at Colorines there has grown a sprawling village which the Commission finds it difficult to control. At one time, when the plants were being constructed and the roads opened up, it numbered as many as 40,000, including workmen and their families not only belonging to the Commission itself but also to the many sub-contractors. Now the population has shrunk again, but the village is still big and rather dirty.

The Santo Tomás reservoir was formerly the site of an Indian village, which has now been moved to what the local people like to call the "newest village in the world". (See Figs. 6, 7, 8.) This new Santo Tomás is high on the cliffs, and the change in climate must have been not inconsiderable for peasants who had formerly lived in the true tropics below. There was some resistance to the change of site, but troops did not have to be called out as at Tigne in France. Here in Mexico the Church intervened. The parish church itself was the first of the new buildings to be erected, and the Bishop then preached a sermon sympathising with

FIG. 3. *Right:* The oscillating well under construction above Tingambato.

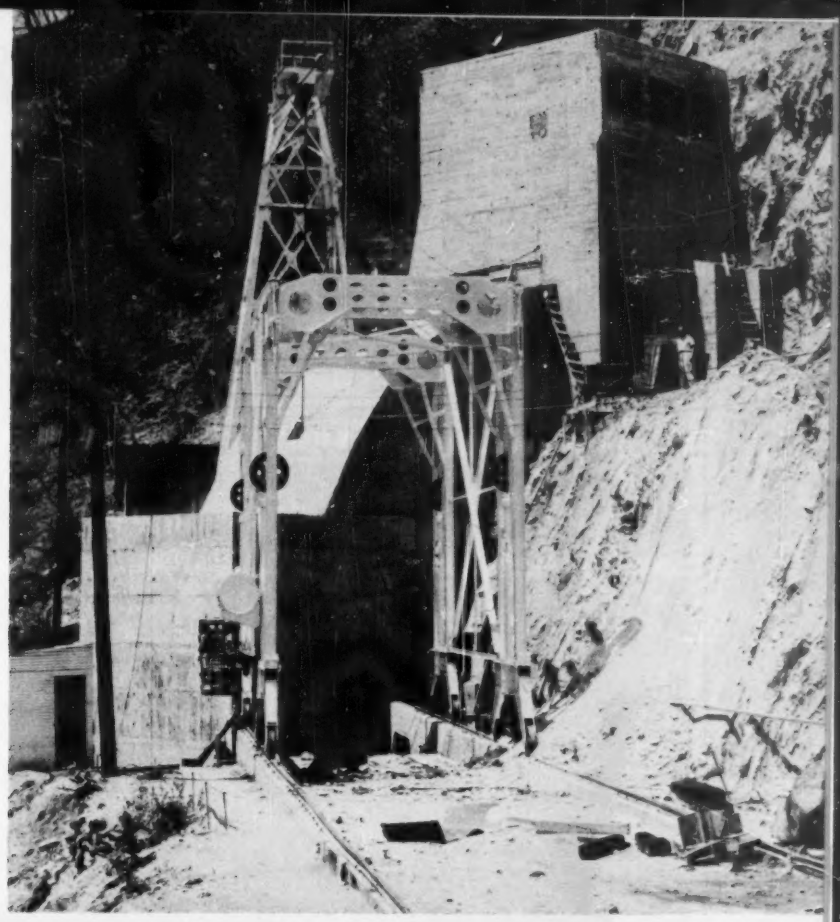
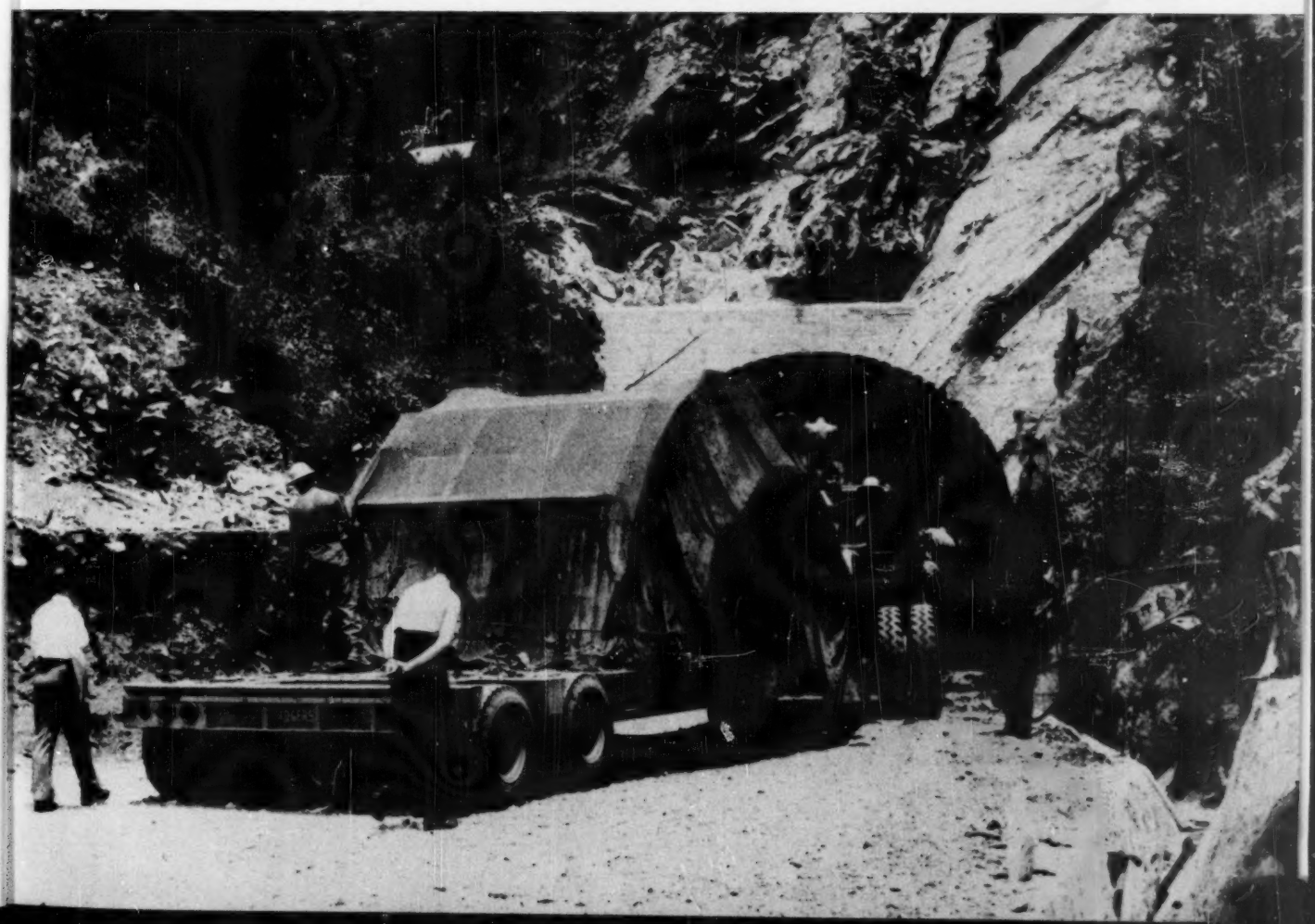


FIG. 4. *Below:* Entry tunnel into the underground plant at Tingambato.



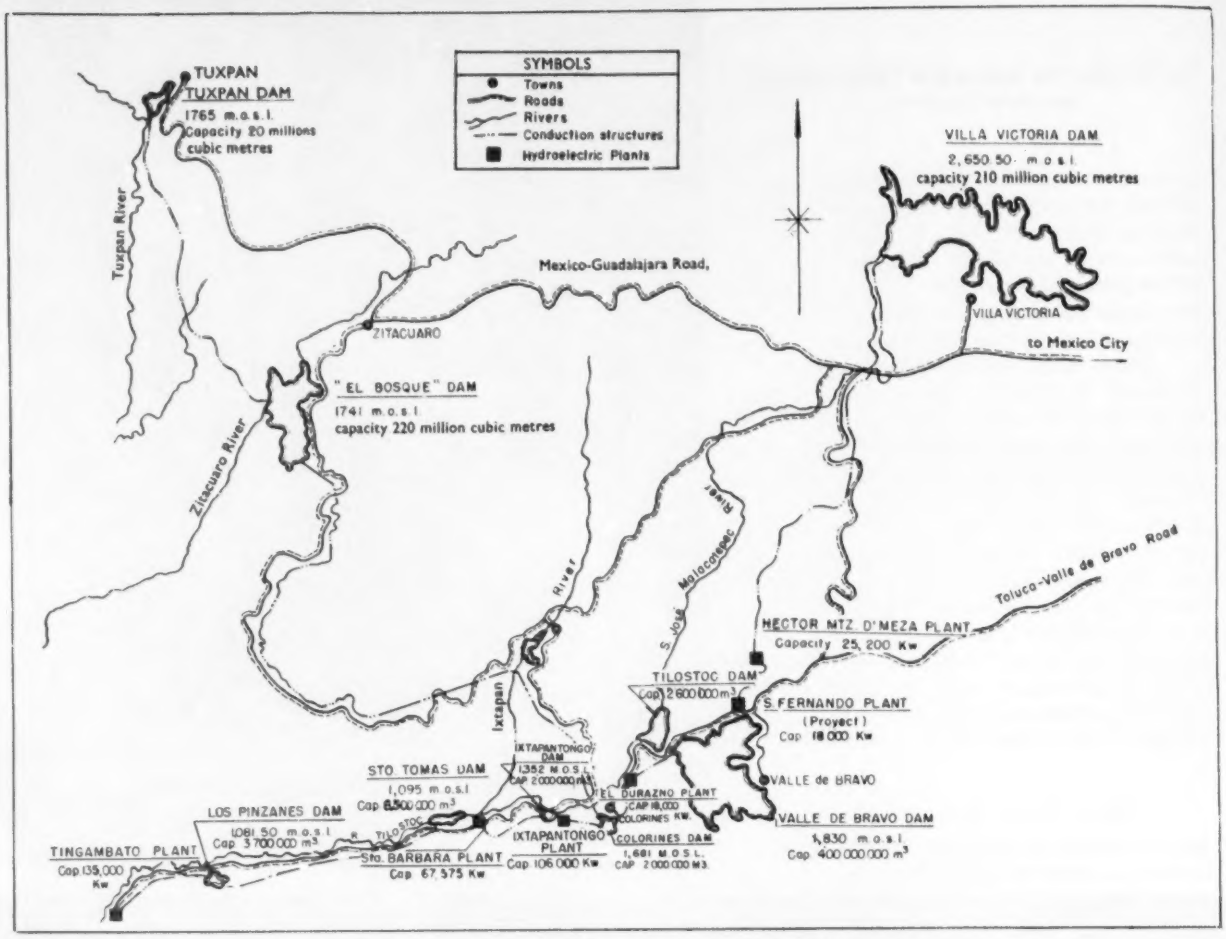


FIG. 5. General plan of the Miguel Alemán Hydro-electric System.

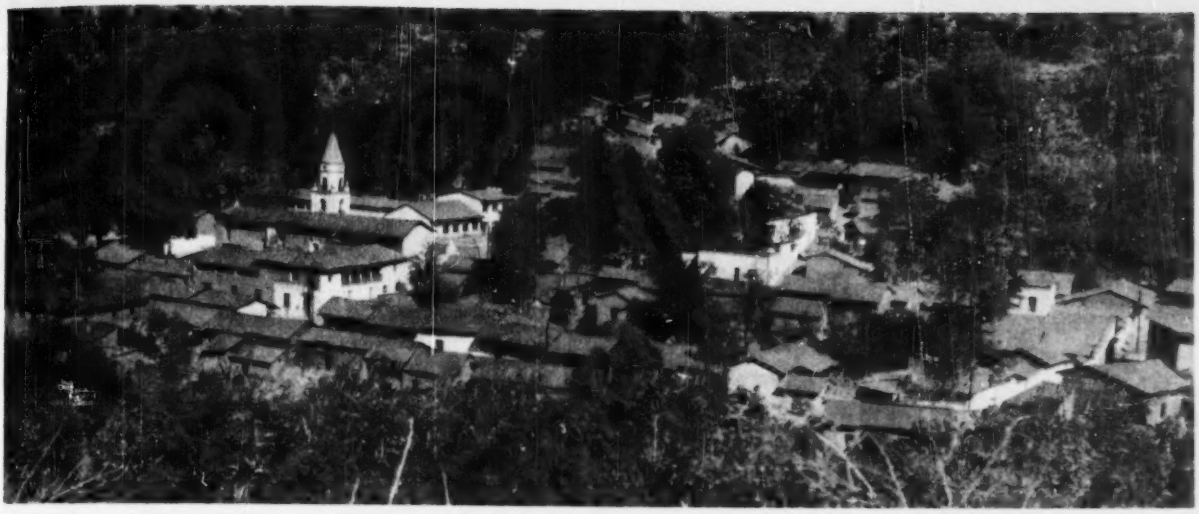
the villagers for the sacrifice they must make, but urging them to comply for the sake of the many, as against the few. With Indian docility they complied, and they now live in the clean and colourful houses provided for them. The peasants' holdings are some distance away, the houses being packed close together on the hillside, and it is a cause for discontent that the men have too far to go to their work. Moreover, there is nowhere to put the animals, so that donkeys, goats, and even pigs are living in modern quarters with their owners. No doubt the Commission will learn from this mistake in planning and will put any future village closer to the cultivable land. In the meantime, rising out of the reservoir of Santo Tomás, the old village church tower still stands to remind the inhabitants of their former homes. The tower is only of adobe, yet shows no signs of falling. The villagers would have liked to move the cemetery with them to the cliffs (bones and all), but this request was not complied with!

A serious problem in so unpopulated a land is how to reach the isolated and tiny communities of peasants in order to instruct them in the dangers of electric equipment. Ramón Rubín, a Mexican writer who knows the peasants well, tells a story about two poor and ignorant Indians who chanced to build their shack near a new electric pylon. Wanting wires for their fences, innocently they climbed in search of this desirable raw material that had been sent them from heaven, so it seemed, and were electrocuted.

Informed Mexicans say that this story is not exaggerated. Notices are, of course, put up wherever there is danger, but many of the peasants cannot read. However, news travels surprisingly quickly in these parts, and gradually the population is beginning to realise what they can, and what they must not, touch.

THE OLD TOLTEC PAST

This whole region, so remote even today, was once a centre of Toltec culture, and wherever the Commission builds and spreads, it finds prehispanic remains. It is since the Commission came to the district, for example, that some Toltec wall paintings have been discovered on the walls of a gorge near Ixtapantongo, almost facing the new Santo Tomás. These paintings are unique in the world, for they are at least nine centuries old, and yet—in spite of being on the rock wall in the open air, and not inside a cave—their colours are richly preserved to this day. The excellent preservation may be due not only to the durability of the paint and to a layer of chalky deposit which now covers the wall-face, but also to the superstitions of the peasants living in the neighbourhood. They call the place "Devil's Gorge", and will not go near it. Only now that the paintings have been rediscovered by the outside world is there a danger of vandalism, and the Archaeological Institute has placed a lonely sentry there to protect the scaffolding erected for study, and the paintings themselves.



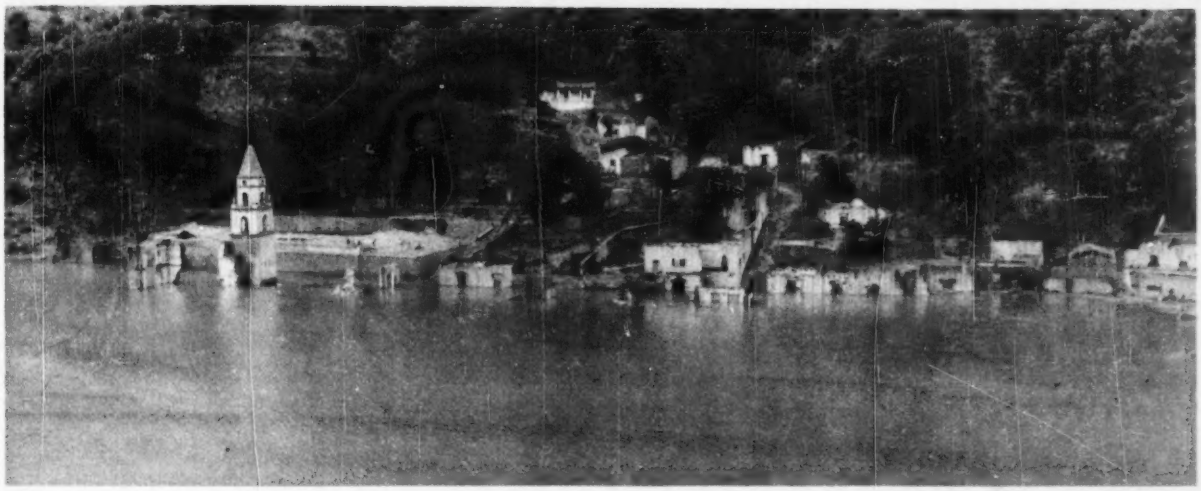


FIG. 6. The old village of Santo Tomás. FIG. 7. Photographs taken during the flooding of the old village. At the time of writing the church still has its bell tower above water. FIG. 8. The new village of Santo Tomás with church.

FIG. 9. *Left:* Drawing after Toltec wall painting. (*By courtesy of Agustín Villagra.*)

FIG. 10. *Right:* A section of the wall painting above Ixtapantongo. On the left are primitive drawings in black-and-white. On the rock face to the right are Toltec paintings, done in colour. In the lower right-hand corner are a sacrificial scene and the sacrificial tree with skulls. Above this, among the men taking part in a ceremony, one is wearing the mask of a dog. Still higher are the gods of dance and drink, and at the very top are the innermost and highest Toltec gods. (*By courtesy of Agustín Villagra.*)

Access to the site is by a precipitous path which clings to the face of the gorge about three-quarters of the way up the cliff wall—the whole wall being about 800 ft. high. The river which flows below may have deepened its bed somewhat during nine centuries, but the site must have been difficult of access even in Toltec days. Sulphur springs give the waters downstream a deep-yellow colour. Snakes and scorpions abound, the numerous caves being so full of them that it is unwise to enter.

Ranging from 12 to 30 ft. above the approach path are the paintings themselves. One can climb up by ladder and scaffolding to where the rock face begins to jut outwards, so that some of the paintings are virtually hanging over the precipice.

But what astonishes most is not the daring of the site and its secrecy (for the paintings cannot be seen, and never could have been, until one is practically upon them) but the exquisite fineness of the drawing and the evidently careful preparation of the rock face to receive the mineral colours. No reproduction can do justice to the delicacy of rendering, which seems to me superior to that in Mexican paper codices. Some polish or varnish that has been given to the surface produces, too, a subtlety of colour like shot silk.

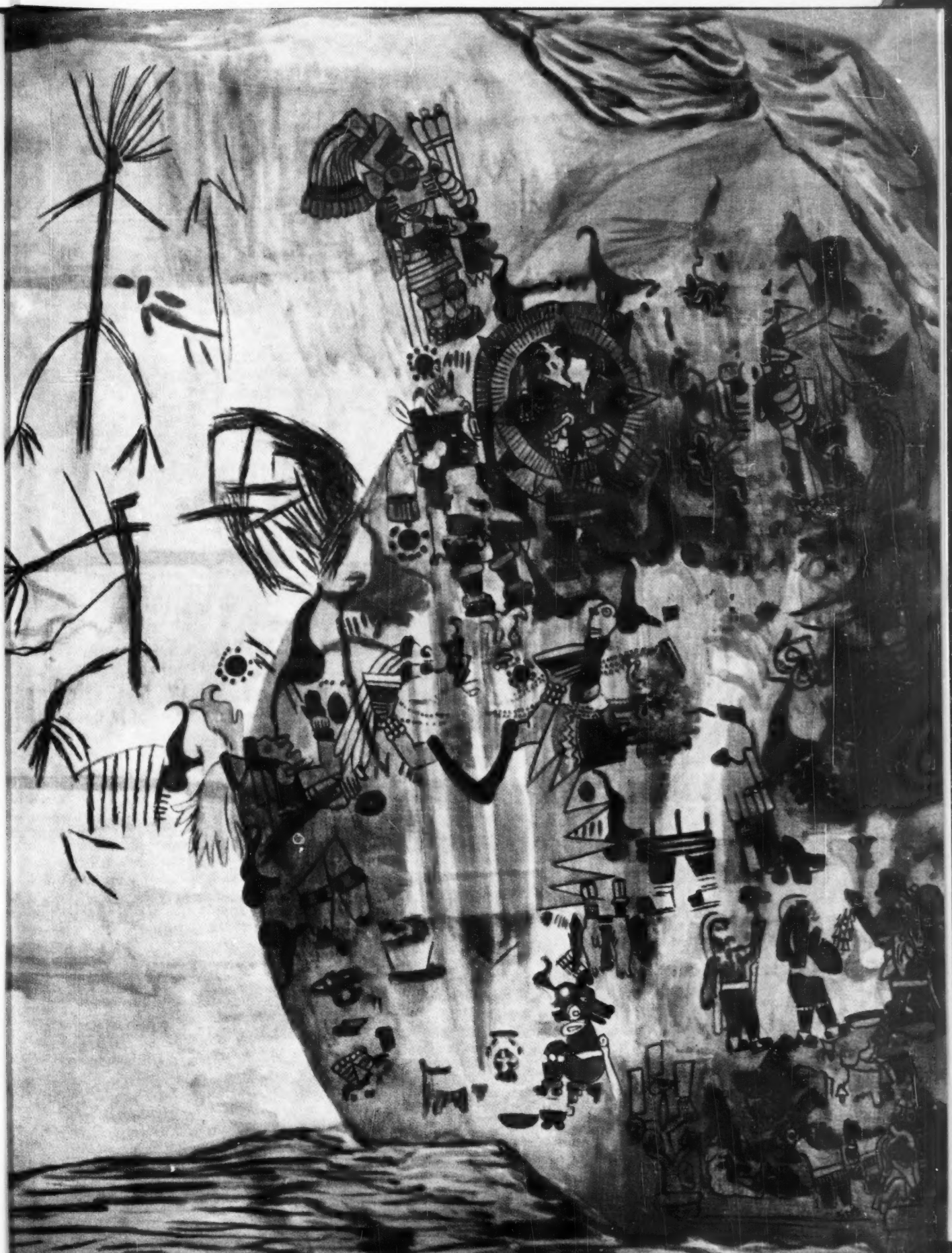
Studies of these paintings have been made by two Mexican archaeologists, the late Mateo A. Saldaña and Agustín Villagra. Villagra is now discovering that more and more of the rock face has been used for what is virtually a religious book of the ancient Toltecs.

At first one can make nothing of these paintings, but a spraying of oil and water brings the ancient colour vividly alive. There are three distinct styles, representing three different epochs. The first is primitive, but the drawing is strong. There is a little man in bright yellow with arms outstretched, in the manner of a child's drawing; and many abstract shapes like combs, leaves, and especially crosses with branches at each arm (Fig. 11). There are also faces shaped like suns. Three colours are used: orange, yellow, and black.

Advanced Toltec paintings of the 11th and 12th centuries A.D. have been placed beside these primitive ones. One of the best preserved rock faces shows three different groups of figures, one below the other (Fig. 10). The lowest are human beings, about an inch high, and here we see a sacrificial scene, and beside it the *Colorín* tree. The *Colorín* still grows abundantly in the district, and its bright red bean-shaped flowers (a source of food for the peasants) are sufficiently suggestive of hearts to have been made a symbol for sacrifice. In the drawing the tree is hung with human skulls.

Above are the gods, drawn larger, their vestments picked out in great detail. They are perhaps three inches high. The lowest of them, immediately above the humans, seem to be the gods of drink and intoxication. Above are the chief gods of the Toltecs and of all the Nahua-speaking peoples of Mexico, down to the Aztecs, who turned up late on the scene as conquerors, only in their own turn to be conquered by the Spaniards.

Villagra identifies one of the higher gods as the god of war, another as god of sacrifice, and a third as Quetzalcóatl, the plumed serpent, symbol of Venus. There is also Tezcatlipoca, "Lord of the Smoking Mirror", or god of the noumenal world. Villagra reads these figures from top to bottom, and regards the human sacrifice as actual and bloody. It can be argued that the wall painting should be read from the bottom upwards, in which case the sacrifice is seen to be symbolic. Otherwise there is a curious anomaly in the skulls hung on a tree, a *growing* thing. If



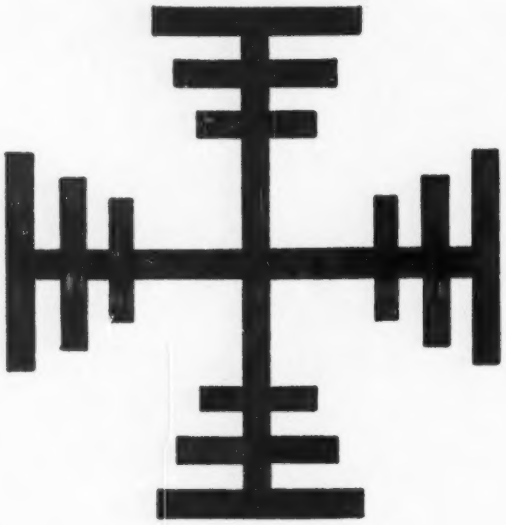


FIG. 11. Typical "cross" on wall paintings above Ixtapantongo.

the sacrifice is symbolic, then through giving up their hearts, humans are reaching to the gods. Perhaps they may have been aided in their ascent by drinking *pulque*, which is made from the maguey cactus and which was probably capable of inducing visions when mixed with narcotic mushroooms. But the highest gods of all are above these gods of liquor, and must represent the final and highest aim of sacrifice.

Above this threefold panel there is another, less well-defined. However, it is possible to see a series of gods, one above the other, apparently arranged on some kind of ladder, or on some growing vine leading upwards. The figures in this series are larger, perhaps six inches high.

Musicians also appear in these Toltec paintings: trumpeters, drummers, and men playing the clappers or timbrels symbolic of the rain god Tlaloc. The trumpets are particularly interesting as being very long, like those found in Tibet.

Various ceremonies seem to be taking place among the humans, some of whom are dressed in masks of eagle, monkey, deer, coyote, rabbit, and flower. The butterfly, a recurring Toltec symbol also belonging to the rain god, is also visible. In one place (Fig. 9) a woman is beating a drum with one hand while she offers a bowl of liquor or perhaps chocolate to a plumed warrior.

Yellow, red, green, black, and blue-grey are the colours used. The rock seems to have been prepared with some surface colour mixed with a strong agglutinant, and on to this sympathetic surface the figures have been drawn, sometimes outlined in black, sometimes merely with wedge-shaped strokes of colour.

The third period reverts to a more primitive style and is painted all in black. It seems that Toltec skill had by then been lost.

The rock itself is volcanic, probably including a considerable proportion of iron and slate.

GEOTHERMIC ELECTRICITY

A note on the new development of harnessing geothermic power for electricity may well be added, for it is likely in the future that other interesting archaeological districts will be opened up by the Electricity Commission. Since August 1955 Ing. Luis F. de Anda has been carrying out a series of explorations in various hydrothermal zones. The first zone to produce effective geothermic power is in the State of Hidalgo, west of the City of Querétaro, where the ill-fated Emperor Maximilian went before the firing-squad. A pilot unit of 3500 kW will be installed here, and if this is found satisfactory a plant of 25,000 kW capacity will be built, sufficient to produce electrical energy for the 140,000 inhabitants of Querétaro at an unusually moderate cost. Since Mexico is rich in thermal springs, no doubt this economic source of power will be used in Mexico increasingly to augment the resources of hydro-electricity.

One wonders if it is too fanciful to see a strange touch of fate upon this particular area. The ancient sacrifices, whether symbolic or actual, were made to obtain light; and now apparently by chance, the Federal Electric Commission is established in the same district. This dramatic twist has been remarked on by Licenciado Raúl Noriega, a Mexican civil servant who is also an archaeologist.

Had it not been for the work of the Electricity Commission in opening up this wild district, the paintings would not have been discovered; so today, side by side with these great modern enterprises, the ancient civilisations are being reconstructed and revived. Simultaneously the peasants are living much as they did in pre-conquest times, stacking their maize in great vertical ricks, winnowing by hand, thrashing with mule and donkey in the very shadow of the pylons. It is to be hoped that with the coming of modern technology what is finest in the old will still be treasured and valued.

TWENTY-FIVE YEARS AGO

The plan for a 200-in. telescope for the California Institute of Technology was discussed in an article entitled "Research on the Distance of Stars" by Walter S. Adams, Ph.D. (DISCOVERY, 1933, vol. 14, pp. 41–4). The design of the instrument was "studied with a view to providing the greatest possible light-gathering power to aid in the discovery of nebulae and faint stars, the analysis of their light by the spectroscope, and the extension of the limits of space beyond those which can be attained with existing telescopes".

The provisional design provided for a comparatively short focal length to give great concentration of light, a mirror of low-expansion glass to ensure the quality of the images under varying conditions of temperature, and auxiliary mirrors to increase the effective focal length. The new telescope was expected to multiply, perhaps by a factor of eight, the nebulae then known to exist and to increase by about the same factor the number which could be studied in detail by the aid of variable stars and other recognisable standards for measuring great distances.

THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome

FIG. 1. A P2V (U.S.) Navy Neptune, background for the take-off for the flight of the year to the South Pole. The aircraft is based at McMurdo Sound and is used in support of U.S. scientific studies in conjunction with the IGY.

Vanguard and Afterguard

In November it was announced that the U.S. Army was also to contribute to the American satellite programme. From its inception up to this announcement the U.S. Navy has had exclusive responsibility for getting the satellite into the sky. The Navy's schedule, even after the shake-up that followed the launching of the Sputniks, made March the earliest that a fully instrumented 21-lb. satellite could be launched. On October 23 the *Vanguard* project made an important step forward when the GEC rocket that is to constitute the first stage of the vehicle performed "an extremely successful test" from Florida. This was the last of the three stages to receive its separate test—and to pass it. A previous GEC first-stage motor was rejected on static test in April.

The next step in the *Vanguard* schedule was a test-firing carrying a miniature satellite. The first of these tests was attempted on December 6 amid a blaze of publicity—and with the result known.

It is now possible that the Army may succeed in launching a full-size satellite before March, from one of the Army's missile vehicles. Major-General John Medaris, chief of the Army's ballistic missiles centre at Redstone Arsenal, announced to the Press in November that the Army would be ready to launch a full-size satellite "between the end of the year and March". He saw a 90% prospect of success at the first attempt. He made it clear that work was already in progress on the Army's satellite. In contrast to the Navy's space-laboratory the Army satellite would be cylindrical in shape. It was expected that a *Jupiter-C* rocket would be used. This would have to be modified and fully tested before a satellite launching was attempted. It might require the addition of one or more additional rockets to its present three stages.

Also in November it was reported (by the U.S. Rocket Society) that the U.S. Air Force is already working at its Cambridge Research centre on three 1000-lb. satellites designed to be placed in an orbit 4000 miles above the Earth or even higher. Two new high-altitude research rockets were being developed. Another rocket also under development would make use of the ramjet principle.

The Air Force, it was stated, was confident of launching the half-ton satellites within five years.

100 Artificial Meteors Launched

In October the U.S. Air Force research station successfully fired a number of aluminium pellets described as "artificial meteors" from an Aerobee rocket 54 miles up. Though this was not the first time

such an experiment had been tried (an attempt had been made in 1947 using captured German V2s), this was the first time it had been successful. Photographs taken with a Baker Super-Schmidt camera showed one of the objects travelling at 33,000 m.p.h. (considerably more than "escape velocity") and with a brightness of minus-two magnitude. Two were tracked on November 22, nearly a month after they were launched, and one proved to have a path that was only 25° off the vertical. This made it seem virtually certain that the pellets were falling into the gravitational field of the Sun. A spokesman from the Air Force research station remarked that the pellets should prove valuable as a tool for controlled experiments in the physics of the upper atmosphere. This was confirmed by Dr Nicolet, CSAGI secretary-general and an expert in upper atmosphere physics.

The pellets were the size of small ball-bearings and weighed only a few grammes. A hundred pellets had been fired simultaneously from three shaped charges in the detached tip of the Aerobee rocket. The charge weighed only 25 lb., but it must have had a remarkable explosive power, for the pellets were released at a speed ranging up to 40,000 m.p.h.; an Aerobee perhaps attains 4000 m.p.h. Many of the pellets had presumably gone out at an angle and would possibly circle the Earth in orbits in the way of satellites. Others would presumably fall back to Earth. Two at least appear to have continued in an upward direction at sufficient velocity to escape from the Earth's gravitational pull. Dr Dubin of the research station remarked that "we could hit the Moon but whether you saw it or not depended on how good an optical system you had".

A spate of flying saucer reports this autumn is likely to be associated with this event.

Ambitious Belgian Plans

The Belgian expedition to the Antarctic sailed in the *Polarhav* and the *Polarsirkel* from Antwerp in November. The station is established at 70°26′ S, 23°19′ E, on the sea-ice off Breid Bay on the Princess Ragnhild Coast and will be in operation throughout 1958. It lies ten miles back from the ice-front. The leader is M. Gaston de Gerlache. He was erroneously described as an officer of the Belgian Navy in a previous issue of DISCOVERY; he is in fact a solicitor, but served during the war in the RAF and later in the Belgian Air Force with the rank of Commandant. The expedition reached the area on Christmas Day.

The scientific programme is exceptionally comprehensive. Beside the six studies already announced (see DISCOVERY for February 1957, p. 71), a considerable schedule of surveying and mapping has been included as well as plans to study nuclear radiation both in the atmosphere and of the rocks of the region.

Extremely little is known about this sector of the Antarctic. It has only been visited twice before, on both occasions by reconnaissance aircraft; for the first time in 1937 when a plane from the Norwegian whaler *Torshavn* flew over the area, and then again by a flight of American aircraft during the 1947 exercise Highjump. The only maps available are the very approximate ones resulting from the air photographs taken on these flights. One of the aims of this expedition, therefore, is to prepare the first precise and detailed map of the area. As a first step to this end a reconnaissance party will leave for the mountains of the interior in March. They will proceed up the glacier which breaches the mountain chain here, stocking depots for later sledging parties and making ground "fixes". At the end of 1958 further surveying will be carried out by means both of ground sledging parties and reconnaissance from the expedition's aircraft and helicopter.

The nuclear radiation programme is by far the most complete to be attempted in the Antarctic during the IGY. Regular measurements of nuclear radiation precipitation and in suspension at ground-level will be made. Besides these, ice-cores are to be obtained with a view to determining the changes in the level of radioactivity in the atmosphere since the beginning of the atomic age. Rocks will be collected for dispatch back to Belgium, where their age can be decided by radioactive means. But perhaps the most enterprising experiment to be included in this part of the Belgians' programme relates to the snow and ice that will be melted during their stay at Breid Bay for domestic use. About 200 tons, it is estimated, will be used in this way; all of the resulting water will be passed through very fine filters for the extraction of the meteoric and cosmic dust they contain. This is of special interest since the Antarctic is uncontaminated by the dust produced by human habitation and by industrialisation.

Komsomolskaya and Vostok

At the end of October the Soviet Antarctic station of Komsomolskaya in the interior of the continent was set up by a tractor-and-sledge party. The party then pushed on towards the Geomagnetic Pole where another station, Vostok, was established on December 16.

The co-ordinates of Komsomolskaya are given as 74°05′ S, 97°29′ E. The station stands at 11,500 ft. above sea-level, it is reported. A meteorological programme was started up as soon as the station had been established.

Vostok is situated at 78°27′ S, 106°52′ E; stands 10,500 ft. above the sea and is nearly 900 miles from Mirny.

On December 27 a convoy of ten tractors dragging twenty metal sledges each with a load of about twenty tons, set off for Sovietskaya at the pole of maximum inaccessibility—the last Russian Antarctic station to be established. An aerial reconnaissance lately indicated that the plateau here is at nearly 13,000 ft.

Record Sunspot Number in October

The sunspot number of 263 for October exceeds by a substantial amount the largest number previously observed. The recording of sunspots began two centuries ago, and in May 1779 the number was 238. This previous record was also exceeded in September last year, with 244. Only on three other occasions has the number been above 200—in December 1936 with 206; May 1947 with 201; and in November 1956 with 203. This will be readily seen from the sunspot curve plotted in the June 1957 issue of DISCOVERY's IGY notes.

Dr M. A. Ellison of the Royal Observatory, Edinburgh, who is the British national correspondent for observations of the Sun, makes the following comment about this remarkable solar activity: "The recent high sunspot numbers have been made up mainly by the occurrence of large numbers of small and medium-sized spot groups. On many days in September and October there have been upwards of twenty such groups visible on the disk at one time. There have been few very large groups in 1957; and another unusual feature has been the continued appearance of occasional spots in high latitudes of the Sun.

September also provided a record in terrestrial magnetic activity: there were in all six great magnetic storms with sudden commencements, beginning on the 2nd, 4th, 13th, 21st, 22nd, and 29th. Each of these storms could be attributed to the occurrence of an active solar region in position near the Sun's central meridian at the time. In September there were many disturbances of the ionosphere caused by solar flares. Many of these produced severe radio fadeouts on frequencies of 18 Mc/s and below. Reception from North America was particularly disturbed, especially during the large magnetic storms referred to. Although the sunspot number for October exceeded the high value in September, active solar regions were less pronounced and their terrestrial effects were on a greatly reduced scale.

In September spectacular auroral displays were seen even round London.

TAE's Trials and Triumphs

By the end of the year (1957) Sir Edmund Hillary and his New Zealand party had completed their depot-laying programme and, with plenty of time in hand, decided to make a dash for the Pole. They reached it on January 3, with only a drum of fuel in reserve. Dr Fuchs, painfully proceeding south in bad terrain and further slowed by his scientific programme, was not expected to reach the Pole until mid-January, and was not expected to reach Depot 700 (where Hillary will link up with the crossing party) until early February.

On January 6 the RAF *Otter* aircraft of the TAE achieved a notable record by making the first single-engine flight from one side of Antarctica to the other.

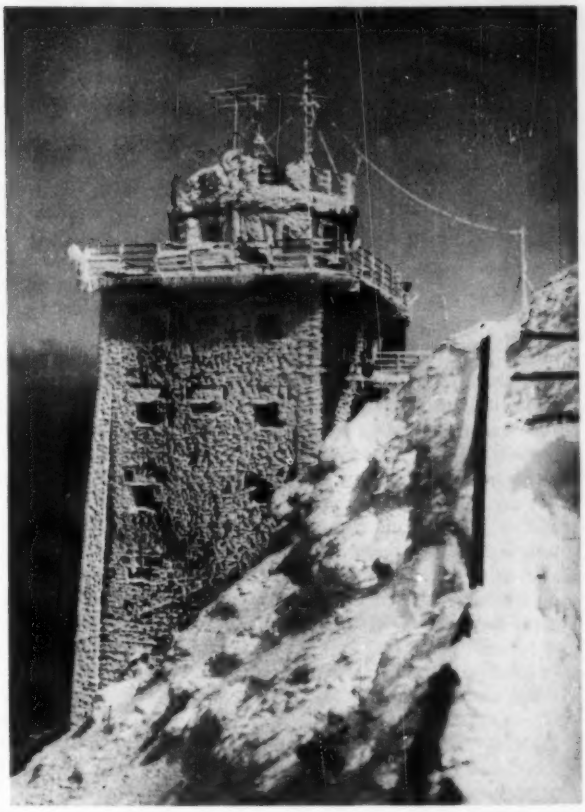


FIG. 2. Lomnický Stít observatory of the Czechoslovak Academy of Sciences, High Tatras (9000 ft.) where cosmic-ray studies for the IGY are being carried out.

"Polar Spur" Seen by New Zealanders

Among the first ionospheric records to be relayed from the New Zealanders' vertical incidence recorder at Scott Station on Ross Island, for analysis by the Christchurch Geophysical Observatory, were a series clearly showing the development of the little-understood phenomenon known as a "polar spur". The phenomenon has also been called by the French *un monstre*! This is how it is described by Mr J. W. Beagley, superintendent of the Christchurch Observatory:

"The 'polar spur' reflection is an oblique reflection obtained from a highly ionised thin layer sporadic in nature, which appears about the height of the well-defined F region of the ionosphere, usually occurring above 200 kilometres".

The series on which the "polar spur" appeared was taken on a night of particularly disturbed ionospheric conditions. The spur reflected the radio pulses up to a frequency of 9 Mc/s per second. On these same facsimile records the F region of the ionosphere showed as a thick ionised layer at a height of approximately 400 km. This was a greater height than is usual and is attributed to the storm conditions. The critical frequency of the F layer, also due to the disturbed conditions, was less than 3 Mc/s. It is anticipated that by the end of the IGY very much more will be known about the behaviour of these "polar spurs" and the effect they have on radio communications.

Highest Wind Observations in the World

Australian weather experts are planning the highest routine wind observations in the world. Members of the Central Weather Bureau in Melbourne began measurements at altitude using a balloon with a valve device made from a ping-pong ball, early in the autumn. (A description of the ping-pong ball balloon-valve developed in Australia appeared in these Notes in April.) These flights have shown that the balloons frequently reach up to 120,000 ft. and Dr Hopper of Melbourne University reported these have shown the existence of an easterly air-stream between 110,000 and 120,000 ft. up moving at the unexpected speed of 90 knots. It was moreover hoped to increase the altitude of the balloons still further. The new technique is being used at fifteen weather stations throughout Australia, already.

Sputniks Past and Future

Official Soviet sources have revealed that the next few satellites to follow Sputnik II will also carry animals, for the purpose of "completely solving" the problem of bringing a creature back alive from a space-vehicle. Not until this was ensured could man venture so far afield.

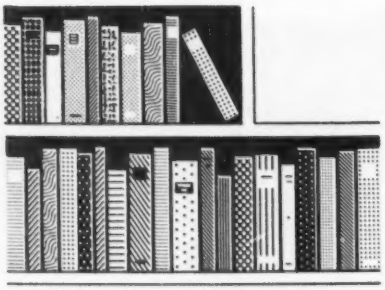
It was also officially stated that there had been no unsuccessful attempts by the Soviet Union to launch satellites before Sputnik I was fired. Prof. Alexander Blagonravov, of the Soviet Academy of Sciences, added, "The reason why the Soviet Union does not report on the launching of satellites in advance is not connected with a fear of failure, but with Soviet scientists' reluctance to say anything prematurely about problems which have not been solved."

Largest Emperor Penguin Rookery

In the Antarctic spring two Australians, returning to Mawson from a reconnaissance flight, spotted what has since proved to be the largest Emperor penguin rookery so far discovered. It was estimated to contain 12,000 breeding pairs, and though only twenty-five miles from Mawson, near the Douglas Islands, it had previously remained undetected, since it is shielded from view by a group of huge icebergs. Shortly after this, another aerial reconnaissance revealed a second previously unknown Emperor penguin rookery. This one lies fifty miles south-west of Davis Station, midway between the Larsemann Hills and Ranvik glacier. Its population is estimated at 1200 breeding pairs.

These two discoveries makes the total of known rookeries up to ten; four of these have been discovered within the last four years by Australian expeditions. The interest in the Emperor and its rookeries derives from the fact that its behaviour is perhaps more eccentric than that of any other bird. It lays its single egg in the autumn and incubates it without benefit of a nest in the open, generally on sea-ice, by balancing the egg on its feet, even during the blizzards and sub-zero temperatures of the Antarctic winter.

THE BOOKSHELF



A Hundred Years of Evolution

By J. S. Carter (*London, Sidgwick & Jackson, 1957, 216 pp., 21s.*)

The approaching Darwin centennial will undoubtedly usher in a harvest of books on evolution, a subject in which interest has markedly increased in recent years. The rather short book of Dr J. S. Carter is a very auspicious beginning, since the need for such a book has long been felt. There is no other book in any language, as far as this reviewer is aware, that not only describes the history of the evolutionary doctrine up to our own day, but also scrutinises the beginnings of theories of evolution from the vantage point of the modern knowledge. The book under review does successfully both things. In only forty-three pages it describes "The Background to Darwin"; it devotes forty-nine pages to Darwin's work and the early post-Darwinian years; thirty-four pages to the early years of the current century, and sixty pages to the more recent developments.

The book is written in a simple and direct style, assuming little previous biological preparation in the reader, and yet it manages to present modern viewpoints quite accurately and to give at least an inkling of the evidence on which these viewpoints rest. To do much more than this would require years of special historical study and a book several times larger. Although such a more detailed study is still desirable, even if it were to be published soon it would hardly displace Dr Carter's book from its ecological niche.

A specialist will find a few points in Dr Carter's book with which to disagree. Thus, this reviewer would question the author's prediction that the future developments in theories of evolution will lead back to a belief in "Lamarckian heredity". Unless these words are used to describe an artificial induction of mutations (and this is not a legitimate usage), there seems to be nothing on the biological horizon to augur so freakish a change in weather. But the fact that evolutionists still disagree among themselves on many points means only that the subject is very much alive and that more research is necessary.

T. DOBZHANSKY

History of Entomology in World War II

By E. C. Cushing (*Washington, D.C., Smithsonian Institution, 1957, 117 pp.*)

Someone (was it Clausewitz?) once remarked that, in considering the outcome of battles, one should remember that an army has, after all, only another army to contend with. Actually, it would be nearer the truth to say of nearly all the great conflicts of the past, "Soldiers have seldom won wars. They more often mop up after the barrage of epidemics. And typhus, with its brothers and sisters—plague, cholera, typhoid, dysentery—has decided more campaigns than Caesar, Hannibal, Napoleon, and all the inspector-generals of history." Hans Zinsser, in *Rats, Lice, and History*, substantiates these words by a brief review of warfare from Xerxes to the Crimea.

The reasons why armies are prone to epidemics are simple. Soldiers in the field are herded together in primitive shelters, with sanitary amenities absent or destroyed; often they travel into distant regions and encounter exotic diseases to which none of them has any immunity. It happens that many of the more serious epidemic diseases are transmitted to man by arthropods. They include typhus, plague, malaria, yellow fever, and relapsing fever, while the enteric diseases are partly insect-borne. For this reason, insect control is a vital necessity to protect the health of troops on active service. This was realised for the first time in the Second World War, though not effectively at the beginning. In the first few weeks of the Solomon Islands offensive, the Americans suffered 10,635 casualties; of these only 1472 were due to gunshot wounds, while 5749 men were put out of action by malaria. The Australians, too, suffered in the early New Guinea fighting, when the malaria rate corresponded to 4000 cases for each 1000 men a year. Enteric infections, partly spread by flies, afflicted about the same number of men as malaria, while many thousands suffered from dengue, sandfly fever, scrub typhus, and scabies.

Colonel Cushing's book shows that, quite early in the war, military authorities were fully aware of the importance of insect-borne disease. Every effort was made to utilise entomological research and to provide field entomologists to mitigate the effects of insect plagues. The early failures were largely due to difficulties in rapidly organising a new type of auxiliary service and to lack of adequate insecticides. The extraordinary ramifications of research field trials and planning which was necessary to prevent insect attacks forms an interesting commentary on the complexities of modern warfare. In one respect the title of this book is misleading, since it is a history exclusively from the American point of view. A few British efforts are referred to, in a slightly disparaging way, and no mention is made of entomological work in Germany and Russia. However, it must be admitted that the Americans are pre-eminent in the efficiency with which they put science into practice, by overcoming what they call "problems of logistics". The value of DDT was discovered in Switzerland, that of BHC in England; but during the war, both were manufactured and put into effective use on an unprecedented scale in the U.S.A. Thus, it was American supplies of DDT powder which quenched the Naples typhus epidemic in the winter of 1943–44.

The American contribution to sanitation during the Second World War makes a very full and interesting account (though it should not be regarded as the full story). This little book is detailed and factual, but the writing sometimes wavers between journalistic and scientific jargon. For example, "This insect murderer was soon identified as a member of the *Phlebotomus* tribe, and the etiologic agent of the strange disease was named *Bartonella bacilliformis*." British readers, too, may flinch at the word "demalarialisation".

J. R. BUSVINE

Materials of Civil Engineering

By J. P. M. Pannell (*London, Hutchinson, 1957, 248 pp., 21s.*)

A foreword to Mr Pannell's book says that every civil engineer will read it with profit and with pleasure, and indeed this must surely be the least that can be said. The practice of civil engineering is still largely an art, and one in which the penalties for failure, or non-success, are quickly experienced and sometimes dramatic. The author clearly understands how dependent a real engineer is on his own particular knowledge, and he is attempting to make available some forty years of very sound experience to others. He succeeds as far as anyone can. His book will be highly valued and bears the stamp of real authority. Most of the main civil engineering structural materials are described and their properties discussed. Steel and timber are considered in more detail than the rest. Curiously enough, the material which is at once the engineer's greatest friend and enemy, water, is not included.

It is unlikely that it will be accepted uncritically by some specialists and laboratory workers. For example, the chapter on soils makes nothing of recent hypotheses on the behaviour of fine-grained

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materials in respect of pore and effective pressures, but whether this is of great significance is as yet a matter of opinion. The day-to-day practice of engineering is bound to lead to a certain detachment from the enthusiasms of the laboratory, and neither side is wrong in this dilemma. Additionally, very early in his book the somewhat sheltered habits of thought of a port engineer peep through when he states that it is not prudent to save on first cost at the expense of later renewals and maintenance. If this were so, it would bring much needful construction to an end and, indeed, would often be completely antipathic to the thinking of other nations and other engineers.

If any substantial criticism can be levelled at the book, it is that the author is much less discursive than his experience would justify. Who would suspect from his text that the British steel industry has not yet produced a full range of British broad-flanged or Universal beams, a more economical and useful type than the British Standard beam? Is our concrete even as robust as the best the Romans made? In other situations, why do we have to use concrete of very substantial strength and expense when all we need is a little strength and a lot of weight? Why is there so little progress in the development of effective timber preservatives? There are quite enough engineers who patiently accept materials as they are sold, and only a few who maintain pressure for better ones. It is felt that the author might reasonably have expressed more of the opinions he must surely have formed during his long service to engineering.

The book is well presented in a legible type. The author's drawings are interesting and instructive. Most of the photographs have that dull, lifeless quality so typical of British civil engineering publications. One despairs of ever finding out whether it is the climate, the photograph, or the reproduction which is so discouraging, but justice is not done in this book to the text by the illustrations.

Engineers are notoriously reluctant purchasers of technical books, perhaps because their libraries are so good, but your reviewer believes he would have been a more competent engineer if he had had this book as a student, and he feels much better for having it now.

N. J. COCHRANE

Schools of Psychoanalytic Thought

By Ruth L. Munroe (*London, Hutchinson Medical Publications, 1957, 670 pp., 42s.*)

The appearance of a first-class textbook in any field is a fairly uncommon event. In this particular field it is literally unprecedented. Most studies which might superficially be compared to the book under review are vitiated by a polemical approach which leads to the presentation of a stereotyped caricature of those viewpoints to which the author is opposed. Miss Munroe has achieved a quite astonishing feat of sympathetic insight into the viewpoints of each of the schools with which she deals. The ideas of the classical Freudian school, as well as those of Adler, Jung, Sullivan, Horney, Rank, and Fromm are all expounded clearly and systematically. Each section was written with the active collaboration of responsible members of the school dealt with therein; the author tells us, in one of the side comments which lend a pleasantly informal tone to the book, that "Specialist readers who have read my account of schools other than their own seem to have two reactions—my account of *their* school is good (but) my account of the *other* schools is inaccurate, they say, because I read my own intelligence into them, with insufficient knowledge of their history and actual practice". She argues convincingly that this criticism is not well taken, and that "it is the schools, not I, that have supplied the liberalising intelligence of each presentation, in some contrast to the narrow shibboleths by which they are often identified".

The hatred, ridicule, and contempt poured by each psychoanalytic school on all the others has many parallels in the history of medicine, though fortunately few in other departments of science; it may have something to do with a deep-going insecurity in the doctors' half of the doctor-patient relationship. Possibly Miss Munroe's admirably sympathetic objectivity owes something to the circumstance that her own professional responsibilities have been confined to diagnosis and teaching. In any case, she has accomplished something very much more valuable than a mere digest of the writings of leading psychoanalysts. By her own methods of exposition and comment she has gone some way towards providing the sort of "neutral" conceptual framework within which some genuine comparison of their points of view is possible.

The extreme flexibility of her own approach is well shown in the enthusiastic welcome given to the work of the European ethologists like Lorenz who have been patiently working to clean up the Augean stables of instinct theory. The welcome of the psychoanalysts themselves has on the whole been distinctly cooler.

This book is one which can be recommended without reservations to the psychologist who has to teach something about psychoanalytic ideas to undergraduates, and to the psychiatrist in training, as well as to the general reader seeking light on human behaviour. The analytically sophisticated reader may be a little disappointed at the relatively very small amount of space given to the "English" (Kleinian) school, but this is entirely justifiable in a book intended primarily for the American reader. The little which is reported on this point is scrupulously fair, and it may be no bad thing to be reminded how unimportant this quarrel looks from the other side of the Atlantic.

J. S. HAYES

Anatomies of Pain

By K. D. Keele (*Oxford, Blackwell, 1957, x+206 pp. with xii plates and 14 text figures, 27s. 6d.*)

Although the scientific investigation of the anatomical and physiological mechanism underlying the sensation of pain is a comparatively recent pursuit, interest in pain as a concomitant of disease is almost as old as civilisation itself. Indeed, there have been few serious thinkers in the past who have not at some time or another turned their attention to the problem of pain, and in this respect there can be few concepts at present engaging the attention of physiologists and philosophers which have not been, to some extent at least, foreshadowed in the past. Unfortunately, it is all too easy to overlook this fact, and it is fitting that amid the spate of papers and monographs on pain which have appeared during the past few decades some attempt should be made to show the essential continuity of thought from the earliest medical traditions to the present day.

In the preface to this monograph, Dr Keele states that his purpose has not been to give a complete history of the subject of pain, but only to trace the growth of anatomical and physiological concepts which lie at the root of our present ideas. However, in the relatively brief span of 200 pages he has succeeded in reviewing every major advance in the field from the fanciful traditions of the ancient Egyptians, Indians, and Chinese to the recent work on the brain-stem reticular formation and the non-specificity of sensory nerve-endings. Inevitably much has been omitted, but in the seven chapters of which the book is composed the most significant contribution of each age is indicated and assessed in the light of the preceding knowledge. The important work of Bell, Magendie, and Müller which led up to the discovery of the spino-thalamic tract is rightly seen as the turning-point of the modern era and is fully discussed in what is probably the most valuable single section of this work. Unfortunately, as in the later chapters, this section is occasionally marred by a certain looseness of terminology (for example, the use of "cortico-thalamic" where "thalamo-cortical" is implied), but to enter a caveat such as this is to carp at an otherwise carefully documented and scholarly work.

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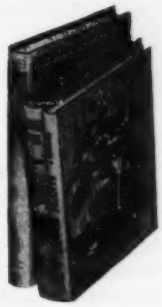

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Wonderama

By Angela Croome (*London, Adprint Ltd, 1957, 77 pp., 7s. 6d.*)

I like books with lots of illustrations, but not too many. The book I have just read, and which I am reviewing, is just right. If it had not enough photographs, it would be too boring, because of all the descriptions. It has six chapters each dealing with one important modern marvel, they are: the atom, probing space, seeing stars by radio, automation arrives, beneath the sea, and wonders of the electron microscope.

This book is more for boys than girls, because boys are more interested in scientific things. The publishers say the book is "for children between the ages of eight and ten", but I disagree, because the average nine-year-old would not get to the end of the book. "Wonderama" is well written, but needs some concentration; particularly pages 10 and 13, dealing with uranium fission and fusion. I personally found these pages a bit difficult and rather boring, perhaps because I am a girl, although nearly twelve years old.

Each chapter starts with a brief introduction by Eamonn Andrews, which I like. Nearly all the illustrations are very good; I like particularly the ones on page 47, the robot, and on page 63, the widow sea-anemone, as well as the mudskipper on the same page.

I think the book gives a child who does not know anything about scientific things a good general view; parents might also like to read it, although they might already know some of the contents.

PAULETTE SAINSBURY

Old Stone Age

By Stevan Celebonovic and Geoffrey Grigson (*London, Phoenix House, 1957, 96 pp., 30s.*)

This book of lovely photographs by Stevan Celebonovic was first published in Geneva and Paris with a French commentary by Prof. Marc Sauter of the University of Geneva. Here it is in an English edition without the commentary of Sauter but a fresh commentary by Geoffrey Grigson. Sauter's ideas were mainly factual and archaeological; Grigson, in his commentary, has written more from the standpoint of the series in which this book is published. The series is entitled *Nature and Art* and purports to "interpret . . . the age-long interplay of nature and man". We are told of this volume that "it is a striving, by a modern visual technique, after the whole point of archaeology; to understand how men lived and what manner of persons they were", and that "poet-scientist" Geoffrey Grigson is endeavouring "to guess what passed in the minds of these Stone Age men". These publishers' claims, to which perhaps photographer and author do not subscribe, should not deter archaeologists and those interested in prehistoric art from buying this book; it contains some superb photographs of Upper Palaeolithic art—some well known like the Venus of Willendorf, or Brassempouy or Lascaux and Niaux; others, like the human figure carved from the root of a horse's tooth from Bedeilhac, and the female figurine from Sireuil in the Dordogne (used very effectively on the cover of the jacket) not often seen in the standard books. Nothing but the highest praise can be given for the photographs; of course, every archaeologist's selection of pictures would be different, and I find it a sad waste that half a dozen plates should be devoted to such things as folds in tertiary schist, molars of mammoths, and the imprint of a quaternary oak leaf. But we soon get over these and reach the miracle of Palaeolithic art, a miracle of achievement, and also, as Grigson says in the closing words of his commentary, a miracle of survival, "that after so many thousand years it can be seen, photographed, and gathered into the plates of such an album as this".

GLYN DANIEL

Microscopium

By Maria Rooseboom. (*Communication No. 95 of the National Museum of the History of Science, Leiden, 1956, 59 pp., 115 illustrations including 6 colour plates*)

A number of books on the history of the microscope exist but none can compare with this new work by Dr Maria Rooseboom. It is quite clearly a labour of love on the part of the author, and the limited English edition is a superb production. The publication of so slim a volume on a rather specialised subject would not have been possible in the normal way without financial assistance, and this has been provided by Pfizer Ltd.

Most authors of works on the history of the microscope have produced books which, while excellent in their way, are more or less catalogues of the principal technical developments of the microscope and its accessories. Books of this kind are of interest only to a limited number of readers who probably already have some knowledge of the subject. They are consequently somewhat dry reading. Dr Maria Rooseboom's book is in an altogether different category. It is a fascinating book because the history of the microscope is presented as a living story of the development of new branches of medical and biological knowledge made possible only by the slow development of the microscope. Presented in this way, the history of the microscope assumes a new interest and becomes absorbing reading.

It is perhaps to be regretted that a limited edition of so fine a work, which is to be privately distributed, must restrict the circulation to a small number of readers. The story told is of such general interest that a very much wider circle of readers would find this little book both enjoyable and full of interest.

R. McV. WESTON

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(*Oxford University Press, 21s. each*)

How to make a subject "come alive" is a recurrent problem for all keen teachers; and a map in actual relief (as museum curators and travel agencies have long since discovered) makes an immediate appeal to people who are unmoved, not to say bewildered, by the maps in an ordinary atlas. A model in miniature of a country or a continent is instantly recognisable as a representation of actuality. But very few teachers of geography have hitherto been able to make use of such models, since relief maps, even if obtainable, were necessarily cumbersome (and expensive) things. The Oxford University Press has now solved this particular problem by issuing a series of ten maps stamped in relief on plastic sheets which can be rolled up and stored in cardboard cartons; so that all ten could easily be carried in a small suitcase. The maps measure 24×16 inches, and can be pinned up on a wall or a blackboard. The subjects are: South England and Wales, Scotland and Northern England, and Ireland, on a scale of 1 inch to 16 miles; Europe, on a scale of 1 inch to 100 miles; and the U.S.S.R., Southern Asia, Australasia, Africa, North America, and South America, on a scale of 1 inch to 300 miles.

The maps are uncoloured, except that oceans, seas, and main rivers are shown in blue. Political frontiers are marked by black dotted lines. There are no names, or lettering of any kind, but the lines of latitude and longitude shown will enable students to "place" towns, railways, or other details; and markings on the map can be made in pencil or water-colour, and can be readily removed. One small criticism must be made: the blue lines of the rivers are presumably printed on the plastic sheets before the relief is stamped in, with the result that they do not always coincide with the valleys through which they flow, and here and there one discovers a river flowing up a mountain-side or climbing over a ridge of high ground. But this is a small point compared with the general effectiveness of the maps, their lightness and convenience, and their comparative cheapness.

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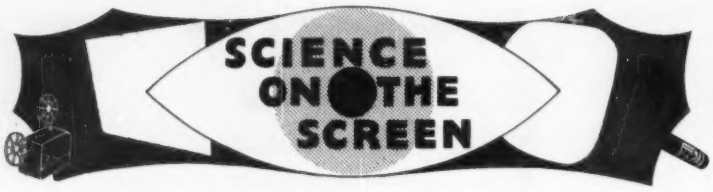


Science for Adults on BBC

At long last the BBC has begun to rectify one of its major programme defects. It now appears to appreciate one of its important responsibilities in adult education. For on no less than ten consecutive Thursday nights, commencing on November 21, a novel television series has begun entitled "Eye on Research". Edited by Aubrey Singer and produced by Alan Rees, the programme structure consists essentially of interviews conducted by Robert Reid as reported outside the studio. It is immediately clear that such an arrangement has immense potentialities if correctly carried through. Indeed, the advance announcement is gratifyingly ambitious and comprehensive. The programmes so far scheduled are dealing with the following fields: (1) aerodynamics, (2) heredity, (3) automobiles, (4) neurology, (5) laboratories of the DSIR, (6) Harwell. In each case the camera is intended to go directly to the place of activity and enable us, so to speak, to peep back-stage—an admirable idea.

Already the first two programmes given, "Wings of the Future" and "Pattern for Life", were a notable contrast in both presentation and in content. Whilst the second was an outstandingly brilliant performance from start to finish, the first, on the contrary, exhibited many inherent weaknesses which it is to be hoped will be severely avoided in future broadcasts.

This first programme, "Wings of the Future", involved a visit to the formidable and massive aerodynamics research wind-tunnel at the Royal Aircraft Establishment, Bedford. It was clear that the main object was to show the wind-tunnel in operation for the study of airflow around high-speed aircraft and rocket missiles. The broadcast was effectively an interview with the research director, with supporting experimental demonstrations. Most unfortunately the language used was frequently far too technical. Mach numbers were flung airily at us: the term "model incidence" was used several times without explanation. The viewer (note, this is the average man, not the trained scientist) was really expected to understand without further explanation such terms as "manometer", "digital computor", "Schlieren picture", "force and moment", "subsonic flow", and so on. To expect descriptions involving such terms to be understood widely is shockingly unrealistic, to say the least.

Here, of course, we have met just that very old familiar pitfall which the experienced lecturer is always meticulously careful to avoid. There is always a great danger of obscurity from unfamiliar terminology when interviewing an authoritative specialist in some field of specialised technology, particularly if that authority devotes his time only to research and is not accustomed to the arts of teaching. For let there be no mistake about it, the popularising of highly technical scientific research is a very skilled art indeed.

Nevertheless, despite the obscurities, the visit was most impressive. The colossal size of the 80,000 h.p. equipment needed to study even a small model at very high speeds was rather staggering. However, most unfortunately even the fine experimental display was ruined by a faulty camera-switching technique. The centrepiece of the whole show was the demonstration in the wind-tunnel of some really exciting Schlieren pictures of the airflow around an advanced model of an aeroplane. The whole discussion preceding was effectively leading up to the experimental demonstration of the establishment of shock waves as the velocity increased: very much a real live broadcast indeed. Yet just at the exciting moments, when attention was fixed on the model as the air-speed increased to the critical value, the producer chose to switch the camera back and forth to quite meaningless dials, intended (one supposes) to register air-speed, although one could not even see the figures. Continuity was broken and this wrecked an otherwise admirable, one might say brilliant, demonstration.

Now, on the contrary, how perfectly delightful during almost every moment, was the second broadcast, "Pattern for Life". This was arranged as an informal conversation with the distinguished geneticist Prof. C. H. Waddington in his laboratory at Edinburgh. Whereas at the Royal Aircraft Establishment it was the colossal machinery that impressed one, here, on the contrary, it was the personality of the man that left its mark. Here was the real thing, with no need of millions of pounds to support the research. A distinguished experimenter, taking off his jacket, getting down to the microscope (quite a simple one), and delicately dissecting tiny eggs with fine needles. With nothing more to hand than a simple bench microscope, a handful of mice, and a few flies, it was soon abundantly clear, even to the uninitiated, that here really fundamental research into the mysteries of heredity was being carried out.

The very simplicity of the whole programme was intensely powerful in its effect. The television camera was really admirably employed, particularly when recording Prof. Waddington's micromanipulations.

However, the outstanding characteristic of the broadcast was the clarity of explanation of every single technical issue, and there were many. In fact, Prof. Waddington gave a virtuoso display of just how perfectly an experienced teacher can expound technological material in simple language. Every scientific term used (and they cannot be avoided) was explained and clarified with grace and ease and with an elegant economy, such that each experiment described was a model of lucidity. Mark you, this was only true when Prof. Waddington held the floor (which was largely the whole of the time), for his assistants, when they did appear, were at times not so lucid.

In this broadcast Robert Reid was very helpful indeed, adroitly leading Prof. Waddington, by judiciously well-placed questions from pure genetical research to economically important aspects of animal genetics, stock breeding, and radiation damage. When comparing and contrasting these first two programmes in the new series nothing emerges more clearly than the fact that, more important than equipment, experiments, or the aims and the social significance of the researches, is the necessity for a research director, skilled in the didactic and pedagogic arts as well as in his own field, as the subject of the interview. Such people, we know, are hard to find, but they exist, and should be exploited for the general good. If it so happens that the distinguished scientist who is being interviewed is not too happily gifted as a teacher (and this is not unusual), then it behoves the reporting interviewer to act as a brake by being extra careful to ask for explanations of technical terminology. S. TOLANSKY

New Scientific Film Lists

Among the more interesting recent publications of the Scientific Film Association are its Catalogues of *Films on Psychology and Psychiatry, Education,* and *Cerebral Palsy*. These contain critical appraisals of 130, 100, and 43 films respectively, compiled according to the procedure described in *Scientific Film Review*, vol. 3, No. 6. This Journal lists in its recent issues films on Work Study, Building, and Polar Research.

FAR AND NEAR

Aslib Conference on Library Services in Technical College

Some 300 delegates (principals and representatives of technical colleges and education authorities, and others) from many parts of the country attended the Aslib conference on Library Services in Technical Colleges held in the Connaught Rooms, London, on October 30.

In his opening address, Sir Edward Boyle, Parliamentary Secretary to the Ministry of Education, said that technical colleges were no longer considered as a second choice, they were an integral part of the education service, providing facilities that could not be found elsewhere, and easily accessible libraries were part of their essential equipment.

The chairman of the morning session, Alderman J. W. Brown, Chairman of London and Home Counties Regional Advisory Council for Higher Technological Education, said that it was estimated that recent developments in scientific discovery had quadrupled the amount of knowledge required by a man. The only way that so much knowledge could be made available was through the provision and use of technical libraries.

The Earl of Verulam then presented a stimulating paper, "Libraries: a liberal element in education". He asserted his firm belief that the future of the country depended not so much on industrial power as on pioneering achievement. Most of our great scientists were remarkable for their breadth of vision and the humanity of their characters. A liberal education was the foundation of such leadership and its natural corollary was a comprehensive library, to break down the barrier between one subject and another and to encourage the inquiring mind to seek and to find.

Mr S. T. Broad, Education Officer for Hertfordshire, speaking on "A technical library service" said that there were two aspects of this need: the dissemination of information, and the creation of the right kind of receptiveness.

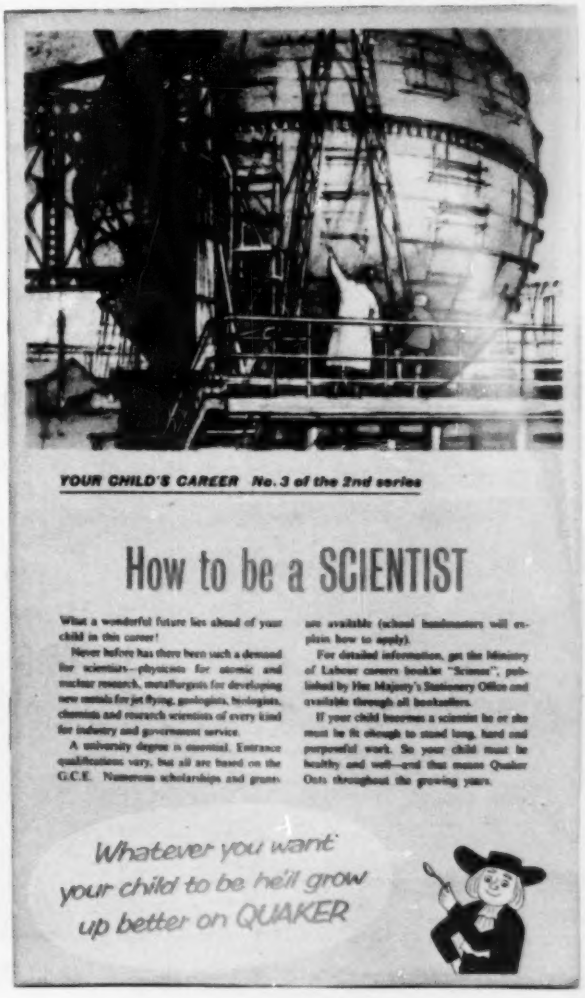
The afternoon session of the conference was devoted, as the chairman, Sir Wavell Wakefield, M.P., pointed out, to more detailed consideration of how the library could be used actively by both teachers and students. Dr J. Topping, Principal of Brunel College of Technology, Acton, spoke first on "The technical college library as an educational instrument". He welcomed the present trend in technical colleges for emphasis on education rather than mere training and stated that the library should be regarded as essential as the laboratory or workshop. But the mere provision of a good library was not enough, the student must be taught how to use it to the best advantage in order that he might keep abreast of rapidly expanding knowledge and be able to make an intelligent attempt to solve those problems with which he would be faced in the future.

Mr P. P. Love, Director of Research and Development, Glacier Metal Co. Ltd, speaking on "Co-operation with local industry", said that co-operative arrangements between local industry and library services in technical colleges were already operating in various areas, but were sometimes hampered by the existence of too many publications of too low a technical standard. He thought that the standard of information services could be raised in quality and speed if a status rating could be given to each addition to technical libraries.

During the discussion which followed a number of speakers suggested that the main difficulty of providing adequate technical library facilities was one of finance. The Chairman said that money was a question of priorities and suggested that each delegate should go back and persuade those who were responsible for providing finance that libraries were a first priority. A full report is published in *Aslib Proceedings*, vols. 9 and 10.

Science Becomes Palatable

Quaker Oats Limited have selected science as one of twelve different careers in an interesting and unique series, which are appearing on the backs of their One-Minute Quaker Oats packs. "How to be a Scientist" is designed to give a few basic facts on science as a career. Most important of all, parents are told how they can obtain detailed information on the qualifications required and types of scholarships available.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The career series on the backs of the One-Minute Quaker Oats packs was first introduced last winter. Because of the very large number of letters received from parents and the interest shown by the appropriate organisations, Quaker Oats Limited have decided to continue this service for a second year.

Standard Frequency Transmissions

The National Physical Laboratory has just published a new edition of the pamphlet describing MSF—the Standard Frequency Transmissions from the United Kingdom. These radio transmissions are on the air almost continuously from the Post Office station at Rugby. They enable anyone needing precise frequency to check his apparatus against a standard which is known to one part in 10,000 million.

The pamphlet announces that the MSF frequencies are now based on the resonant frequency of the caesium atom. Provisionally the value of 9,192,631,830 cycles per second has been adopted for this. This frequency is a fundamental physical constant, free from the small corrections and uncertainties associated with astronomical time. The precise value of the frequency is based on the value of astronomical time for 1955. Some years must pass before the astronomical and atomic units can be compared to the full accuracy attained by the atomic clock because astronomical time must be averaged over a long period to eliminate small errors and uncertainties of measurement. If any corrections prove necessary in years to come, they can readily be made and therefore will not restrict the accuracy already available.

The MSF frequencies and modulations are maintained to ± 5 parts in 10^9 but are monitored to ± 1 part in 10^{10}. The pamphlet entitled "MSF—Standard Frequency Tranmissions from the United Kingdom" is available free on application to: The Director, National Physical Laboratory, Teddington, Middlesex.

Wild Plant, New Source of Textiles

In China a hitherto neglected wild plant known as kender has been found to be of great industrial value for making textiles such as suits and shirts. The existing quantity of this wild plant already exceeds the total output of ramie in China and efforts are being made to introduce it as a regular crop. In the beginning of this year, this fibre will go to feed the country's textile industry.

Tung Cheng-chun, a research worker at the Academy of Sciences who discovered the value of the plant, told *Hsinhua* that experiments in using the plant's fibre for weaving linen and mixed linen and woollen fabrics had succeeded.

Analysis showed that the plant's fibre was superior to that of cotton, flax, ramie, and wool in tensility, twisting strength, and fineness. It was also good in its resistance to acid and in lustre, and it could be used to make fishing-net and paper in addition to high-quality textiles.

The costs of production for textiles made of this fibre would in general be lower than ordinary fabrics.

The wild plant is one of the Apocynaceae, of which the two most common species in China are *Apocynum lancifolium rus* and *A. henderson hooki*. It is one of the dog-bane family, to which the common periwinkle in this country belong. They abound in southern Sinkiang, Hopei, Shansi, Kansu, Chinghai, northern Kiangsu, and Shantung provinces. Since it was first discovered growing in quantity in the southern Sinkiang plane near the lake called Lop Nor, it has been christened "lop linen".

At least 400,000 hectares (about 16,195 acres) of such wild plants had been found in the country on first investigation. It would not be very difficult to bring the output up to the level of the country's total cotton output with large-scale cultivation.

The plant is a perennial grass growing as tall as 1 to 4 m. It can stand very hard drought, heavy salt, and severe cold, and experiments prove that it grows very well under cultivation.

The plant was first found to be useful in 1952 but methods of separating the fibre on an industrial scale were made possible only recently.

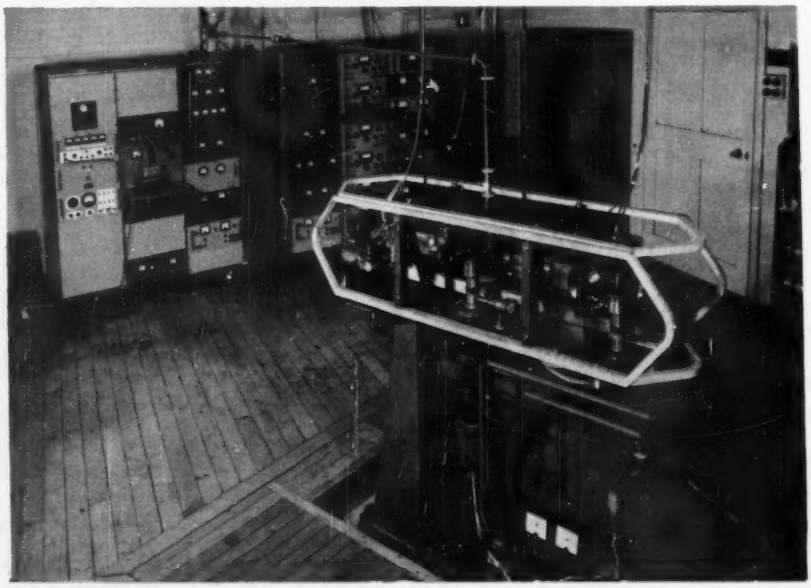
Major Atomic Energy Symposium in Sydney

A major symposium on the peaceful uses of atomic energy will be held in Sydney during the week June 2–6, 1958. The symposium is being sponsored by representatives of the universities, professional institutes, industrial firms, power authorities, Commonwealth and State Departments, and the Australian Atomic Energy Commission.

The symposium will be a forum for the discussion of technical and scientific aspects of the peaceful uses of atomic energy. Papers will be presented by overseas scientists as well as many Australian contributors. Particular attention will be given to the part atomic energy will play in the development of Australia.

Several public lectures are being arranged and will be given by well-known authorities in the atomic energy field. A special atomic energy exhibition is being organised to show developments in uranium mining, research into nuclear power and the industrial uses of radioactive isotopes.

Those wishing to attend are asked to make an early preliminary application to: Symposium on the Peaceful Uses of Atomic Energy in Australia 1958, The Symposium General Secretary, A.A.E.C. Research Establishment, Private Mail Bag, Sutherland, N.S.W., Australia. Applicants will then receive further information when available.



NPL Caesium atomic standard used for monitoring the frequencies of the transmissions.

Calouste Gulbenkian Foundation Grants

The Board of Trustees of the Calouste Gulbenkian Foundation, Lisbon, has announced the Foundation's second list of grants,* totalling over £1 million. Of this total, £403,250 is to be spent in scientific, medical, and other research.

The National Laboratory of Civil Engineering in Lisbon will receive up to £250,000 to build and equip a new research centre, the "Calouste Gulbenkian Institute", for fundamental investigations in civil engineering. The Baghdad College will receive £50,000 towards a Gulbenkian science block for the new Jesuit university (Al-Hikma University). The Sanatorium of Azounieh in Lebanon will receive £20,000 over three years for building a "Calouste Gulbenkian Research Centre for Chest Diseases" to serve the Middle East, £10,000 for laboratory equipment, and £6000 over three years towards the running expenses. The Faculty of Medicine, Lisbon University, will receive £22,500 to install, equip, and maintain for three years a laboratory of electron microscopy in the Institute of Histology and Embryology; and £18,500 to the Laboratory of Physiological Chemistry for essential materials and research. A new Centre for Agricultural Economics in Portugal—£15,000 initially to establish and run the new centre as part of the Foundation's own activities. Sarawak Museum in British Borneo will be granted £5000 for the excavation during 1958 of the great cave of Niah in Subis Mountain. The Institute of Archaeology, Faculty of Arts, Coimbra University, Portugal, will receive £2500 for archaeological research in Iraq. The Office of Town-Planning Research in Lisbon will be awarded £1250 a year for three years.

* The first list of grants, totalling about £500,000, was issued on April 27, 1957.

9th International Botanical Congress

The Ninth International Botanical Congress will be held in Montreal, August 19 to 29, 1959, at McGill University and the University of Montreal, under the auspices of the Canadian Department of Agriculture. The programme will contain papers and symposia related to all branches of pure and applied botany.

Early in 1958 official invitations will be sent to governments. At the same time, basic-information circulars and application forms will be available at the office of the High Commissioner for Canada, Canada House, S.W.1.

All inquiries concerning the Congress should be directed to the Secretary-General, Dr C. Frankton, IX International Botanical Congress, Science Service Building, Ottawa, Ontario, Canada.

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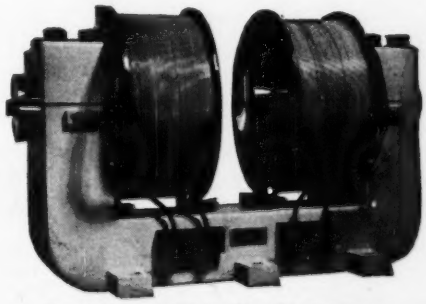

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THE NUFFIELD FOUNDATION SOCIOLOGICAL SCHOLARSHIPS AND BURSARIES

THE NUFFIELD FOUNDATION, in pursuance of its programme for the advancement of sociological studies, is prepared to offer for the academic year 1958–9 a small number of scholarships and bursaries to enable graduates in academic subjects other than the social sciences, psychology or economics, to study the social sciences. The Foundation's particular object is to enable men or women, who are already well qualified in other disciplines, particularly the natural sciences or the humanities, to receive a training in, for example, political science, social psychology, anthropology, social statistics, and sociology generally (but not economics) so that in due course they may undertake research or teaching in the United Kingdom in those subjects. *The scholarships*, which are the senior awards, are intended for persons who have already undertaken some postgraduate work in their own subject. *The bursaries* are intended to enable those who have recently graduated to take a course of training in sociological subjects. In the case of both scholars and bursars the Foundation will pay the cost of university and/or college fees in addition to a maintenance award. Graduates of universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply.

Applications for awards in 1958 must be received before May 1, 1958, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1, from whom full particulars and application forms can be obtained.

L. FARRER-BROWN,
Director of the Nuffield Foundation.

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THE NUFFIELD FOUNDATION, as part of its programme for the advancement of biological studies, is prepared to offer for the academic year 1958–9 a limited number of scholarships and bursaries to enable persons who have graduated in physics, chemistry, mathematics or engineering, but who have had no training in a biological subject, to receive such training in biology as will enable them in due course to undertake research and teaching in the United Kingdom in the biological sciences. *The scholarships*, which are senior awards, are intended for persons who have already undertaken some postgraduate research in their own subject. *The bursaries* are intended to enable those who have recently graduated to complete a course of training in biological subjects including, if considered necessary, a full honours degree course in biology. In the case of both scholars and bursars the Foundation will pay the cost of university and/or college fees in addition to a maintenance award. Graduates of universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply.

Applications for awards in 1958 must be received before April 1, 1958, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1, from whom full particulars and application forms can be obtained.

L. FARRER-BROWN,
Director of the Nuffield Foundation.

LECTURES AND COURSES

"GUIDANCE AND CONTROL OF LONG-RANGE VEHICLES" by Prof. G. A. Whitfield, March 1, 6 p.m., Caxton Hall, London, S.W.1. Admission tickets and copy of full programme and membership details obtainable from the Secretary, BRITISH INTERPLANETARY SOCIETY, 12 Bessborough Gardens, London, S.W.1.

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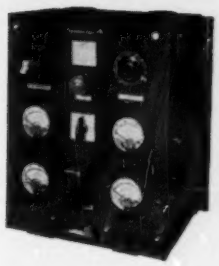

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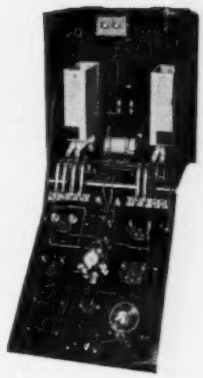

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